GENERATION, TRANSMISSION AND APPLICATION OF THE POWER SERVICES

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HOT LIME-ZEOLITE · p 110

Power

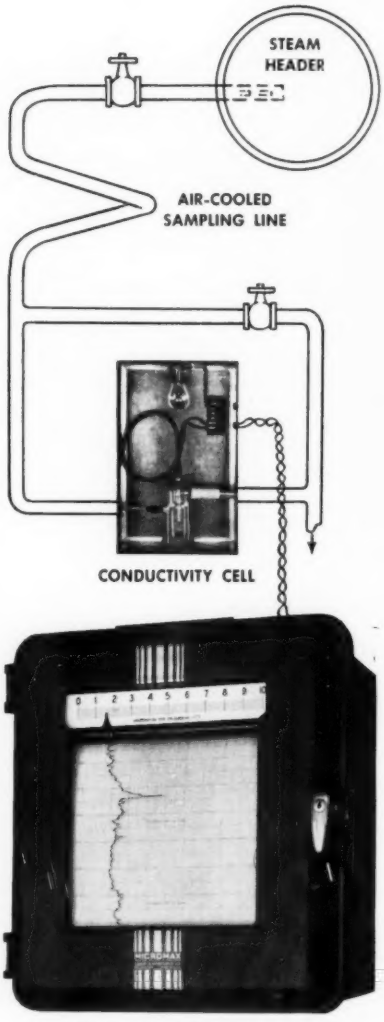
March
1951

A McGRAW-HILL PUBLICATION

New! Simplified equipment for measuring steam purity

DESIGN FEATURES

1. **Partial condensation of sample keeps condensate free of gas.**
2. **No degasifying condensers are required.**
3. **Measures at boiling point; simplifies temperature compensation.**
4. **Unaffected by wide changes in steam pressure and sample flow.**
5. **Air cooled; no water needed for most applications.**



MICROMAX CONDUCTIVITY RECORDER

Here's news for power plant engineers who have been looking for a simple, reliable method for measuring dissolved solids in steam. The Powell-McChesney* Steam Purity Equipment, manufactured exclusively by Leeds & Northrup, makes use of a unique principle which removes errors in steam purity measurements due to dissolved gases, without the use of degasifying condensers. Several years of actual power plant service have proved the ability of the equipment to give dependable measurements with little or no maintenance.

A continuous sample of steam, taken directly from the steam header, is passed through a capillary tube, whose length is calculated for the specified boiler pressure. This tube serves as an air-cooled condenser which partially condenses the steam. At the discharge end of the tube is a flow chamber containing a conductivity cell. Only a portion of the steam is condensed; the remainder is exhausted to the atmosphere, carrying along with it ammonia, CO_2 or other dissolved gases.

Condensate in the measuring cell is in a state of high turbulence which prevents absorption of gases. The excess steam keeps condensate at the boiling point regardless of ambient temperature . . . thus simplifying temperature compensation. Boiler pressure and steam sample flow can fluctuate over a 4 to 1 range without appreciably affecting accuracy.

The Micromax recorder used with this equipment reads steam purity directly in micromhos per centimeter cube, referred to 77 F. It is identical with the instruments used for years by the power industry for measuring condensate purity.

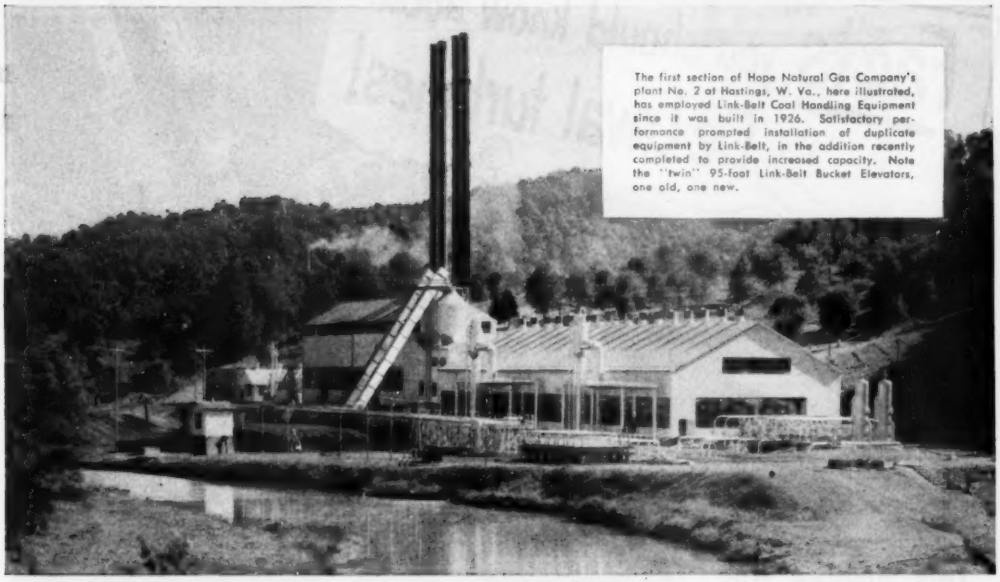
For further details, write to our nearest office, or to Leeds & Northrup Company, 4910 Stenton Avenue, Philadelphia 44, Pa.

LEEDS NORTHRUP

*Developed by S. T. Powell, Consulting Engineer, Baltimore, Md., and I. G. McChesney, Asst. Supt., Rochester (N.Y.) Gas & Electric Corporation.

Jrl. Ad. ND44.95-463(1)

LINK-BELT engineering...



The first section of Hope Natural Gas Company's plant No. 2 at Hastings, W. Va., here illustrated, has employed Link-Belt Coal Handling Equipment since it was built in 1926. Satisfactory performance prompted installation of duplicate equipment by Link-Belt, in the addition recently completed to provide increased capacity. Note the "twin" 95-foot Link-Belt Bucket Elevators, one old, one new.

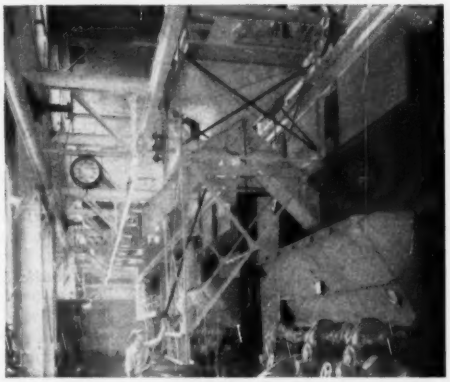
LINK-BELT conveyors...

combine to cut coal handling costs from car unloading to power plant boilers

True 25 years ago . . . true today. If it's coal handling—Link-Belt is your best bet. With a reputation backed by hundreds of efficient installations—Link-Belt has the facilities, the proven equipment and the engineering ability to take complete responsibility from drawing the plans to installation of equipment for delivery of the coal to your boilers. Whatever the size or type of your plant, Link-Belt engineers will aid in giving you the right answer for more efficient coal handling.

Conveyors, elevators, feeders, car spotters and shakers, screens, hoists, hoppers, chutes, gates, stackers, weigh larries and related power plant equipment and accessories—all can be supplied by Link-Belt—*the most complete line* in the field.

Call on Link-Belt for efficient high-capacity, low-maintenance coal handling equipment. Our engineering staff will work hand-in-hand with you or your consultants.



Link-Belt Coal Handling Conveyor Equipment also serves Hope steam plant No. 1. This 6000-lb. capacity Link-Belt Weigh Larry delivers coal from self-draining bunker gates to both the stoker hoppers of old boilers and the new pulverizer hoppers. The latter receive all coal for the additional steam generators installed during recent plant expansion program.

LINK-BELT

COAL HANDLING EQUIPMENT

LINK-BELT COMPANY Chicago 9, Indianapolis 6, Philadelphia 40, Atlanta, Houston 1, Minneapolis 5, San Francisco 24, Los Angeles 33, Seattle 4, Toronto 8, Springs (South Africa). Offices in Principal Cities. 12,201

Facts you should know about De Laval turbines!

This turbine has two traffic cops...

that give you double protection against overspeeding. The normal speed governor and overspeed governor are entirely separate. A sticky governor valve can't possibly jeopardize the operation of the overspeed governor and trip.

You can elect the governor that meets your requirements!

We have eight candidates for the job, so take your choice:

Mechanical Shaft governor with smooth-acting, long-wearing "rocking chair" action.

Vertical Mechanical governor geared to shaft for speeds above 4500 rpm.

Hydraulic Governor. Direct acting orifice-type for high speeds and/or wide range of speed adjustment.

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Flyweight Oil Relay for close regulation such as encountered in synchronous generator drives.

Pressure Controls for constant pressure or differential pressure regulation of pumps, blowers, etc.

Speed Changers, manual or remote control by electric motor drive.

Auxiliary Trips to shut off steam in the event of low pressure in the lubrication system or undue rise of back pressure. Also can be solenoid operated for remote or manual trip, or for inter-connection with the driven machine or any emergency system.

Send for Catalog 4210-34-P

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TURBINES • HELICAL GEARS • CENTRIFUGAL BLOWERS AND COMPRESSORS
CENTRIFUGAL PUMPS • WORM GEAR SPEED REDUCERS • IMO OIL PUMPS

50th DE LAVAL Anniversary

Power

MARCH 1951 · VOLUME 95 NUMBER 3

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(Member ABC and ABP)

Power (with which are consolidated *Science and Industry, The Engineer Review, The Engineer* and *The Stationary Engineer*), is published monthly with an additional directory number in June, by McGraw-Hill Publishing Company, Inc. James H McGraw (1860-1948), Founder. PUBLICATION OFFICE: McGRAW-HILL BUILDING, 330 W 42ND ST, NEW YORK 18, N. Y.

EXECUTIVE, EDITORIAL and ADVERTISING OFFICES: 330 W 42nd St, New York 18, N. Y. Curtis W McGraw, President; Willard Chevalier, Executive Vice-President; Joseph A Gerardi, Vice-President and Treasurer; John J Cooke, Secretary; Paul Montgomery, Senior Vice-President, Publications Division; Ralph B Smith, Editorial Director; Nelson Bond, Vice-President and Director of Advertising; J E Blackburn, Vice-President and Director of Circulation.

SUBSCRIPTIONS: Address correspondence to POWER, Subscription Service, 330 W 42nd St, New York 18, N. Y. Allow ten days for change of address. Please indicate position and company connection on orders.

Single copies 65¢. Subscription rates—U. S. and U. S. possessions: $5.00 for one year, $7.00 for two years. Canada: $7.00 for one year, $11.00 for two years. Pan-American countries: $10.00 for one year, $16.00 for two years. All other countries: $15.00 for one year, $25.00 for two years. Entered as second-class matter January 26, 1949 at the post office at New York, N. Y. under Act of March 3, 1879. Printed in U. S. A.

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POWER articles are indexed in both the *Industrial Arts Index* and the *Engineering Index*. POWER publishes its own index annually, copies of which are available on request to the editorial offices.

GAS-TURBINE research centers, such as General Electric Co's new Aircraft Gas Turbine Lab at Lynn, Mass., are full of dramatic and interesting scenes like that on our cover. Here exhaust from a combustion test stand passes through water sprays for cooling before going into silencers.

With military and commercial-aviation needs as a spur, engineers in this center and many others probe the secrets of this new prime mover. And from the fundamental data they glean will come better materials and machines, not only for aircraft but for your stationary plants as well.

Next month . . .

■ Ever wonder what happens when a big topping turbine trips out? There'll be no need to after you read the detailed report in April on one that did.

■ Figuring how much a straight pipe will move when heated isn't too tough. But when you try to do it for a line with bends in two or three planes, it's another story. That's why designers will welcome Frank Kamarck's article showing how deflections may be figured with relative ease by combining steps of two familiar methods of stress calculation.

■ Ed Kates' outstanding series on diesel instruments and controls resumes in April. This time he tackles the lubrication system. Same practical approach and complete coverage.

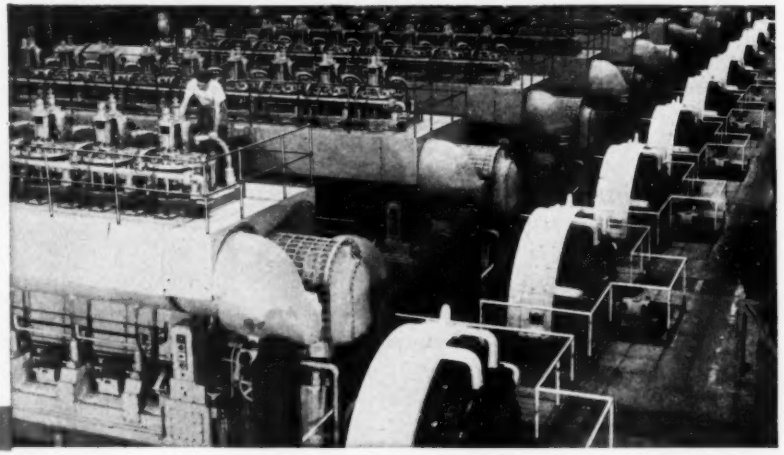
■ Suppose you want to shut down your centrifugal compressor for a week, or longer. Just what should you do to insure best performance when you start it again? That's the kind of practical operating question raised and answered in the second article of the series on these refrigeration units.

. . . and future months

■ Coming soon: A pair of comprehensive articles on coal crushers—what you need to know to select and specify them for best results.

■ And now that you've seen Part I of the new POWER Handbook, we hope you'll keep an eye out for Part II.

GIANT ALUMINUM PLANT GAS DIESELS 100% TEXACO-LUBRICATED



Engines in Reynolds Metals Company Jones Mills Arkansas Aluminum Reduction Plant—one of the world's largest internal combustion plants—include 18 Nordberg Gas Diesels, 9 of which are shown in the illustration. Each of these 9-cylinder, 2-cycle, gas-burning 3,600 h.p. Gas Diesel giants required 16 flat cars for transportation from factory to plant site. *Texaco Ursa Oils* are used exclusively.

Reynolds Metals Company Diesels have used TEXACO URSA OILS exclusively since installation in 1943

For eight years *Texaco Ursa Oils* have given the Gas Diesels in this mammoth installation trouble-free, economical operation. Eighteen giant Gas Diesel engines have delivered full power, with minimum maintenance expense—thanks to *Texaco Ursa Oils*.

Regardless of engine size, efficiency goes up and fuel consumption goes down when you lubricate with *Texaco Ursa Oils*. These fine lubricants resist oxidation, combat carbon and sludge formation, keep ports open and rings free . . . assuring better compression and combustion. *Texaco Ursa Oils* stand up under heat or pressure. Engine parts last longer . . . you save on maintenance costs.

Texaco Ursa Oils are approved by leading engine manufacturers. When you change to Texaco, you'll join the large group of satisfied Texaco users, as witness the fact:

> More stationary Diesel h.p. in the U. S. is lubricated with Texaco Ursa Oils than with any other brand.

Let a Texaco Lubrication Engineer help you to get better engine performance with the *Texaco Ursa Oil* best suited for your operation. Just call the nearest of the more than 2,000 Texaco Distributing Plants in the 48 States, or write The Texas Company, 135 East 42nd Street, New York 17, N. Y.

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...with Power readers...

TOP OR BOTTOM? . . .

I find your publication, particularly the special sections, of great value. Reviewing one of them recently brought up a question. In the layout of a compressed-air system ("How to Save Power Dollars," Oct 1949, p 86), would it not have been preferable to have shown the air inlet connection to the receiver near the top and the outlet near the bottom, as ordinarily recommended by the Compressed Air and Gas Institute and the compressor manufacturers? With this latter arrangement it is believed that maximum efficiency for the receiver will be secured, both as to cooling effect and moisture separation.
Ardmore, Pa. — J M LOY

That's one you can argue on either side, Mr Loy. Both the National Safety Council and the Compressed Air and Gas Institute say the inlet connection may be near the bottom of the receiver if there is enough volume in the tank below the pipe. So a connection at either top or bottom may be used, depending on how you size up the advantages and disadvantages. Practice followed by various manufacturers and design organizations differs.—*Ed.*

"FIRST GAS TURBINE . . ."

While it is true that the unit installed at the Oklahoma Gas & Electric Co is the first gas turbine installed in America ex-

(*Continued on page* 184)

...lines and bylines

START YOUNG in a young organization might well have been the motto of Lou Wirth. He was 18 when he took a technician job in Dow Chemical Co's power department lab—and the lab was just starting, too. That was 1934.

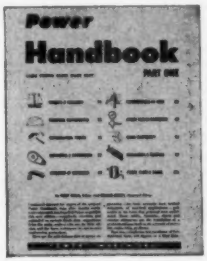
Louis F Wirth Jr

So Lou practically grew up with the water-treatment problems of Dow's huge Midland, Mich. plant. He learned his theory through ICS chem engineering courses at night and put it to work on the job the next day.

This crowded program left little time for the fishing and woodworking he likes to do, but it gave him a real understanding of the water-conditioning problems of high-pressure high-makeup plants—at least if the number of requests he receives to speak is any indication.

Lou left Dow in January 1950, as supt of water treatment for the power division, to become a special service engineer for National Aluminate Corp. He has authored a number of papers on water treatment, the latest of which, written with W S Butler of Dow, deals with the relatively new hot lime-zeolite process (p 110).

MIDNIGHT OIL has burned freely around the POWER offices these last few months as editors sweated to produce the new POWER Handbook (pp 73-104). In Part I alone there are 44 tables, 15 charts, 150 drawings and well over 10,000 closely packed words.



Each of these elements had to be tested for engineering soundness and usefulness, put into the most practical and easily usable form, processed and checked. And we might add, double checked and checked again.

So we're not speaking idly when we say we hope you'll like and use it. Actually, of course, we've got pretty good grounds for believing you will. When we brought out the first edition of the Handbook, in 1943, we weren't so sure. With all the good handbooks available was there room for one specifically tailored for the power engineer? The response to our efforts resolved any doubts. And the continuing demand for this special section spurred us to producing the new one.

SUPERCHARGED GAS-ENGINE developments reported last month by Ralph L Boyer drew considerable interest. We knew they would and were thus doubly disappointed when mail delays kept us from telling you about the author.

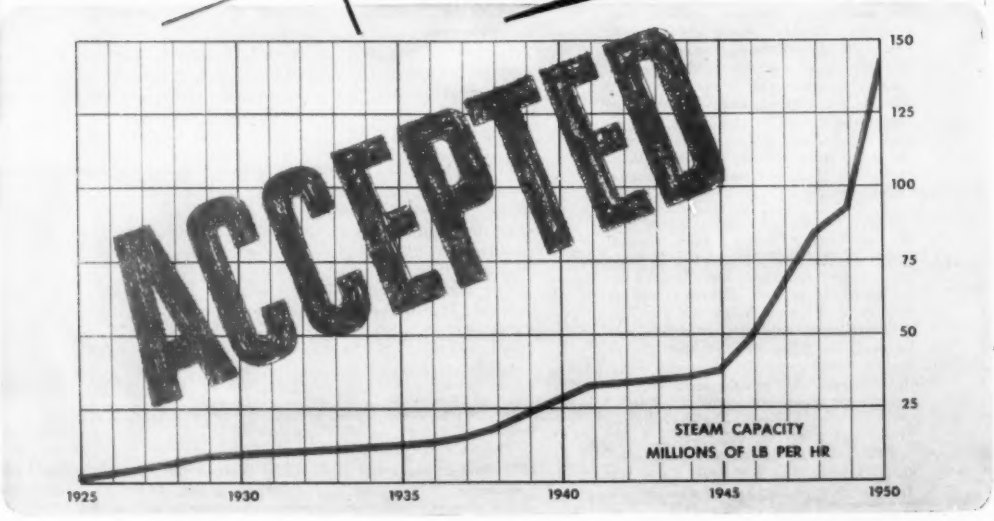
Ralph L Boyer

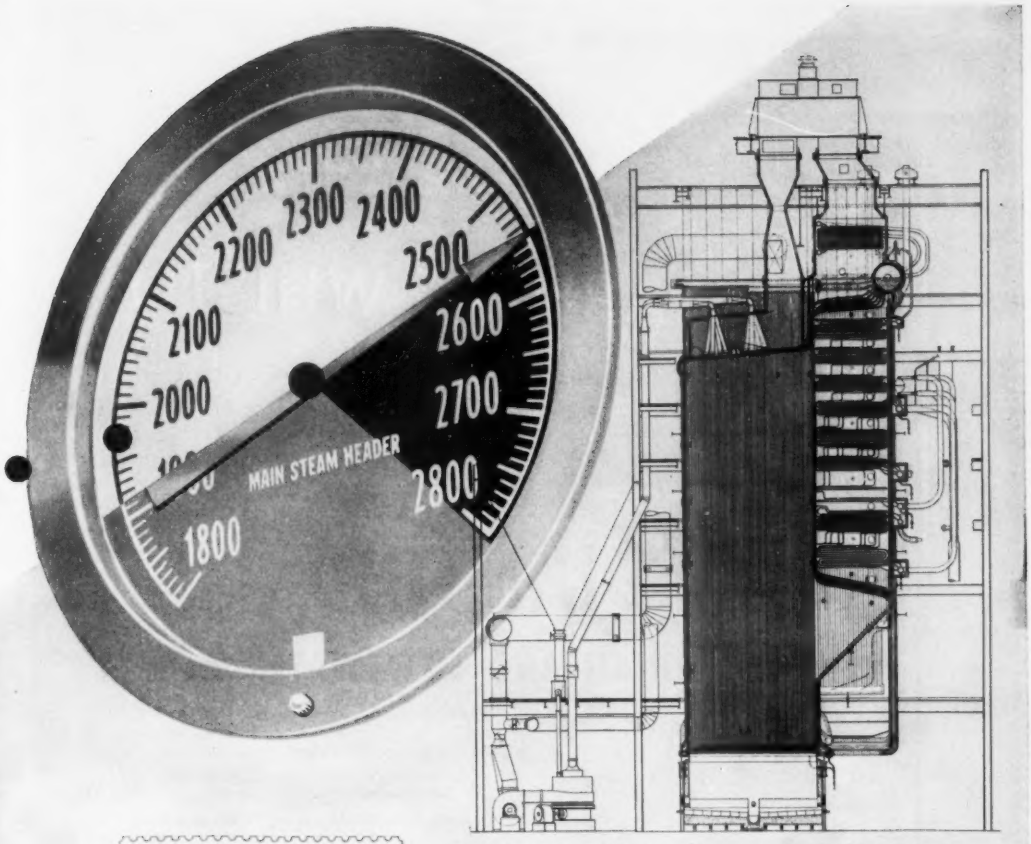
Now vice-president and chief engineer of The Cooper-Bessemer Corp, Ralph started with them in 1926 as diesel engineer. Since then, as he moved from asst chief engineer to chief and then to his present position in 1947, he has made many notable contributions to diesel and gas-engine development. In recent years, particularly, he has pioneered in dual-fuel designs and improvements of the gas engine. In 1950, he was chosen to review American oil and gas power progress at the World Power Conference in London.

Headquarters
For

HIGH PRESSURES

B&W Boilers of 1400-2500 psi serve 15 million kilowatts of generating capacity for 71 power companies





FIRST boiler designed to operate at 2500 psi–1050F. Steam capacity 930,000 lb/hr, with natural circulation.

Another Example of B&W Engineering for Economy

Since 1926, when boiler design pressures first entered the 1400-2500 psi range, B&W has been identified with this presently popular trend toward greater steam-cycle efficiency. This accumulative 25-year experience with natural circulation at the higher operating pressures helps explain why, as the chart shows, B&W high-pressure boilers were preferred for new generating capacity of approximately six million kw during 1950 alone . . . why so many power companies consult B&W first on high-pressure steam requirements with all fuels and firing methods.

Helping America's electric companies to keep power costs down is an 83-year tradition with B&W . . . currently evident in such developments as Cyclone-firing, Pressurized Furnaces, and Gas Recirculation. You'll want to learn the details of these significant features as they relate to your own company's future requirements. The Babcock & Wilcox Company, 85 Liberty Street, New York 6, N. Y.

BABCOCK & WILCOX

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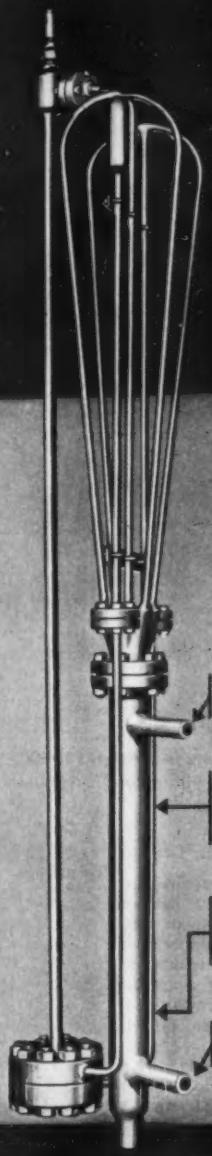
A Dependable

WARNING WHISTLE


Boiler Drum Connection
Whistle Blows When Water Level Rises to This Point
Whistle Blows When Water Level Falls to This Point
Boiler Drum Connection

DIAMOND MODEL "W"

HIGH AND LOW WATER ALARM

Operated by a difference in water heads in a series of upright and inverted U-tubes, this water level alarm is very simple . . . extremely accurate . . . always dependable. Its action is independent of steam pressure or fluctuations in pressure. It operates on all boilers at all pressures but is especially recommended for pressures above 900 psi.

The only moving parts of the Diamond Model "W" High-Low Water Alarm are the bellows and the whistle valve rod. There are no linkages, levers or knife edges . . . and no floats. There is nothing that can get out of order easily. Valve parts and operating rod are stainless steel.

This is an audible water level alarm you can always depend upon . . . a "second sense" for added safety in boiler operation. Ask for Bulletin No. 1012A describing its many advantages and operation.

Write for
Bulletin No. 1012A

DIAMOND POWER SPECIALTY CORP.
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Diamond Specialty Limited • Windsor, Ontario

An Immutable Law of Nature

CORRECT WATER LEVEL READING

DIAMOND

BI-COLOR WATER GAUGE

An unvarying law of nature . . . the difference in refraction between water and steam . . . assures correct water level indication in the Diamond Bi-Color Water Gauge.

Red and green light are directed through the gauge glass. The water refracts the red light out of sight . . . so water always shows green. Steam refracts the green light out of sight . . . so steam always shows red. The junction of the red and green is always the exact water level. The contrast is unmistakable... **and there is no guessing whether the glass is full or empty.** There are no moving parts or linkages . . . and no time lag.

The Bi-Color image is so clear that it can be mirrored from any reasonable height* and through three grating levels to the firing floor without confusion. It can be easily substituted for most existing water gauges, whether of Diamond or other manufacture. Ask for Bulletin 1015.

*Where distance is greater than approximately 100 ft and multiple mirrors are required, or where the cost of keeping the light path clear of obstructions is a factor, the addition of a Diamond "Utiliscope" is recommended. See Bulletin 1025.

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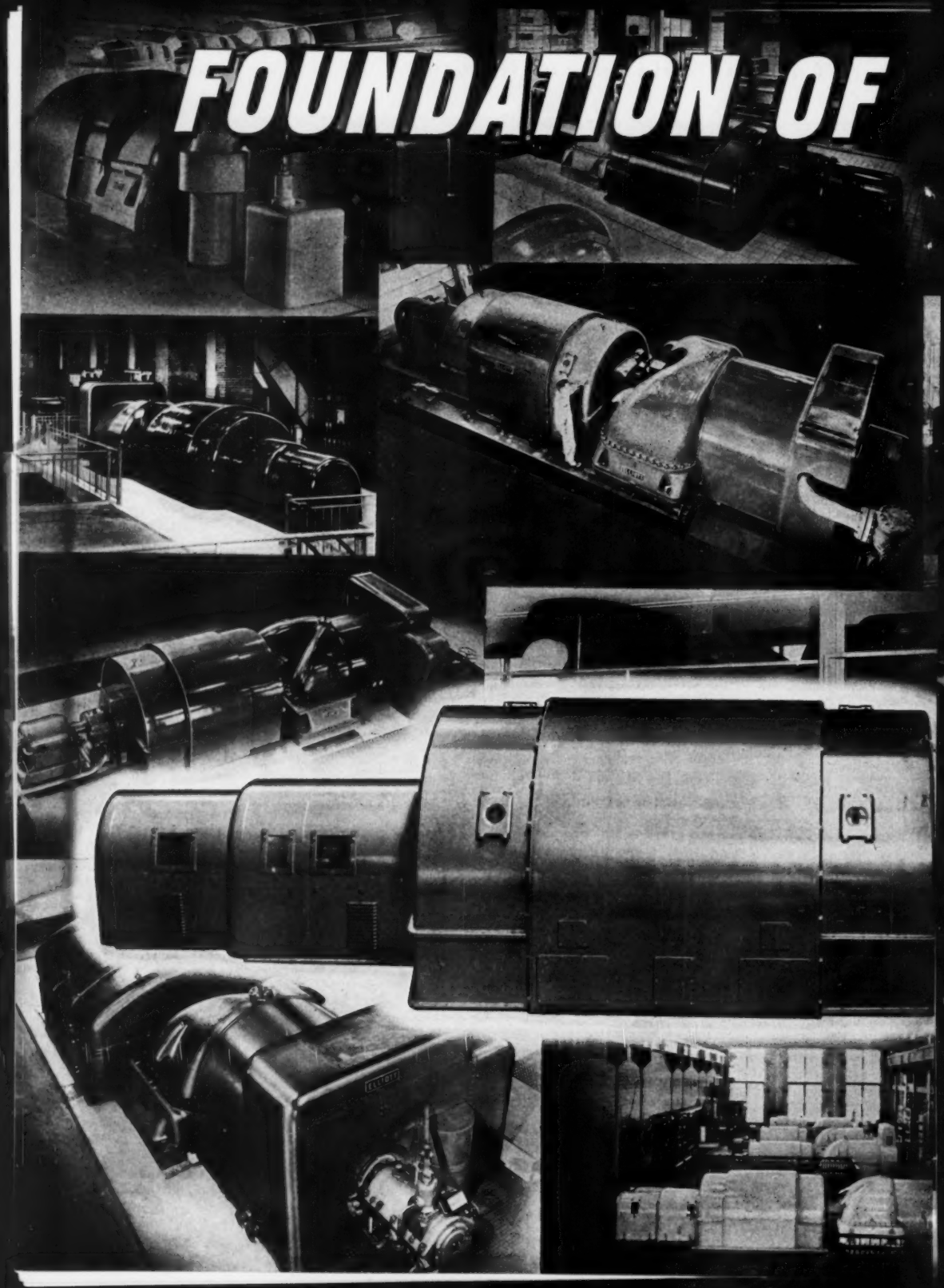

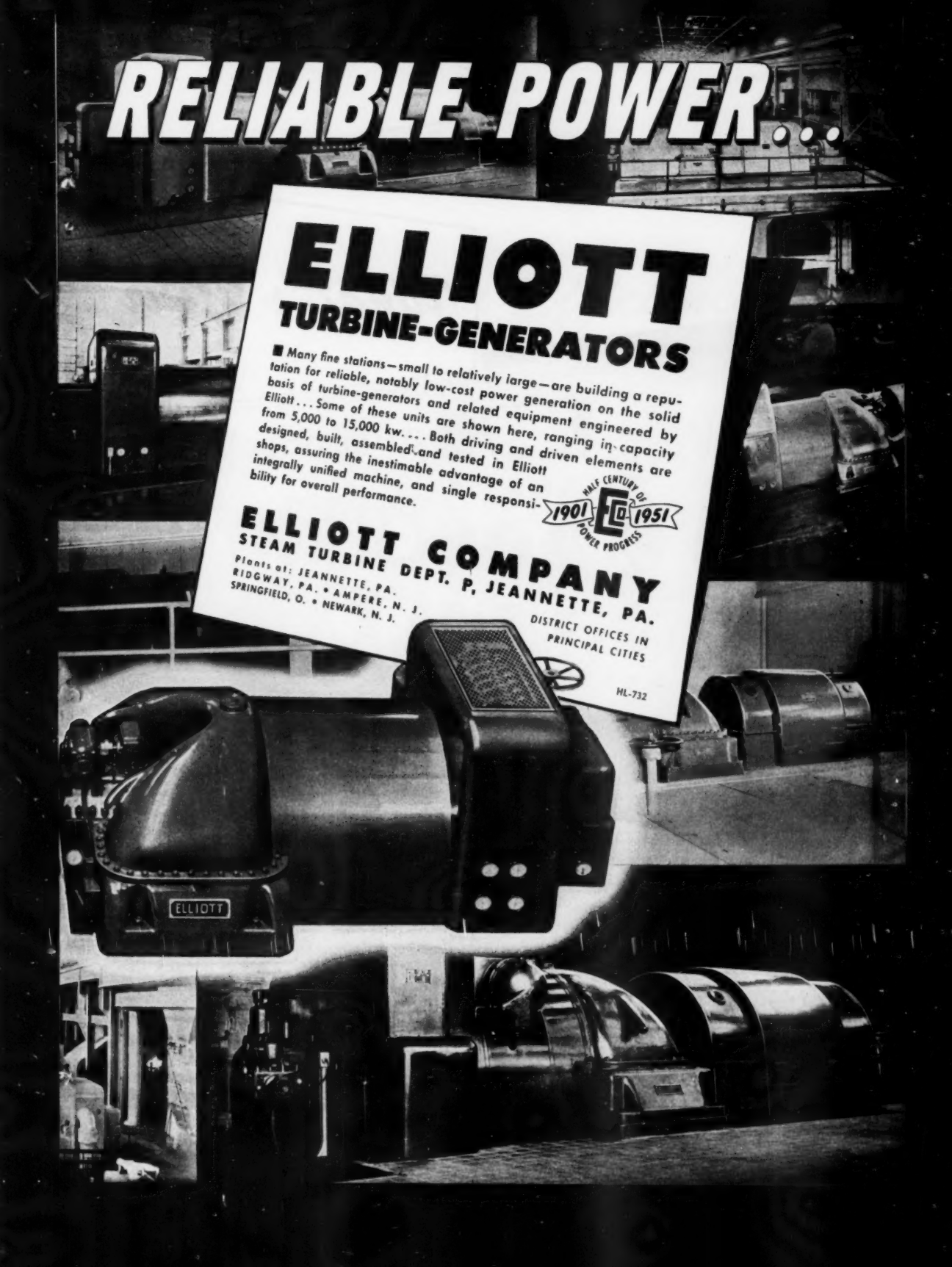
RELIABLE POWER...
ELLIOTT
TURBINE-GENERATORS
■ Many fine stations—small to relatively large—are building a reputation for reliable, notably low-cost power generation on the solid basis of turbine-generators and related equipment engineered by Elliott . . . Some of these units are shown here, ranging in capacity from 5,000 to 15,000 kw. . . . Both driving and driven elements are designed, built, assembled and tested in Elliott shops, assuring the inestimable advantage of an integrally unified machine, and single responsibility for overall performance.
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SPRINGFIELD, O. • NEWARK, N. J.
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HL-732
ELLIOTT

What's Your

This Bailey Boiler Control Panel at Lacombe Station of Public Service Company of Colorado saves fuel and insures safe operation of a 350,000 lb per hr 850 psi, 900 F boiler fired by pulverized Colorado Lignite Coal and/or natural gas.

Controls for Steam Plants

COMBUSTION • PRESSURE
FEED WATER • LIQUID LEVEL
TEMPERATURE • FEED PUMPS

Control-Dollar Efficiency ?

Control-dollars frequently bring annual investment returns of 100% or more. When you buy adequate, well-applied steam plant controls, you increase your dollars' ability to work usefully for you.

That's where Bailey can help: Bailey Controls can give you a better control-dollar efficiency. Here's why:

1. Complete Range of Equipment—fully co-ordinated. You need never worry that a Bailey Engineer's recommendation is slanted in favor of a particular type of equipment, just because he has a limited line to sell—or that Bailey will pass the buck for efficient control; we offer *complete* boiler control systems.

2. Engineering Service—backed by experience. No other manufacturer of instruments and controls can offer as broad an experience, based on successful installations involving all types of combustion, flow measurement, and automatic control.

3. Direct Sales-Service—conveniently located near you. Bailey Meter Company's sales-service engineers are located in more industrial centers than those of any other manufacturer of boiler control systems; you get prompt, experienced service with a minimum of travel time and expense.

For better control-dollar efficiency—for more power per fuel dollar, less outage, and safer working conditions, you owe it to yourself to investigate Bailey Controls. Ask a Bailey Engineer to arrange a visit to a nearby Bailey installation. We're proud to stand on our record: "More power to you!"

A-112-2

BAILEY METER COMPANY

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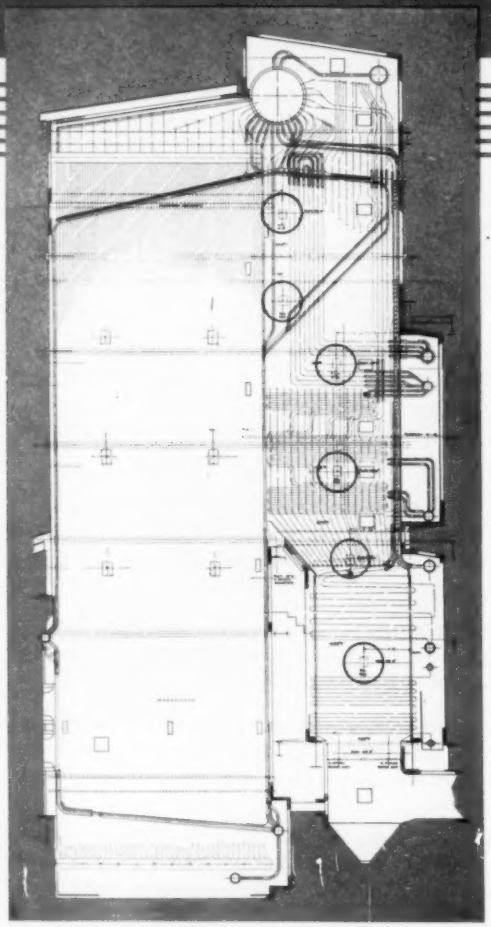
BAILEY METER COMPANY LIMITED • MONTREAL, CANADA

The MONTANA buys VULCAN for



Rated at 675,000 pounds per hour, this Foster Wheeler boiler will deliver steam from the superheater at 920 psi and 905 degrees FTT. Firing will be with Bunker "C" oil and natural gas.

The Vulcan installation will include twelve long retractable soot blowers, plus two controls for the special air-heater blowers. All will blow with steam and be driven by electric motors. An individual push button control for each blower is provided at the boiler operating panel.

Consulting engineers: Ebasco Services, Incorporated, New York City.

VULCAN Automatic

POWER COMPANY this OUTDOOR plant

The FRANK BIRD STEAM-ELECTRIC GENERATING PLANT *at* BILLINGS . . .

Ambient temperatures ranging from —40 to 100 degrees F. will mean many operating problems at the new Frank Bird Steam-Electric Generating Plant. Soot blowing, however, will not be one of these problems. Vulcan automatics will clean the boiler effectively, no matter what the weather.

Driven by electric motors and blowing with steam, the fourteen Vulcans will need no anti-freeze devices—no special provision for lubrication, winter or summer.

With all blowers operated by push buttons on the boiler panel, operators will not need to step outside the control room to keep the boiler and air-heater passes free from soot. They will have no reason to "forget" to blow soot in bad weather. They will have more time for other duties.

Indoors or outdoors, you can depend on Vulcan for effective boiler cleaning over a long service life, with maintenance costs held to a minimum.

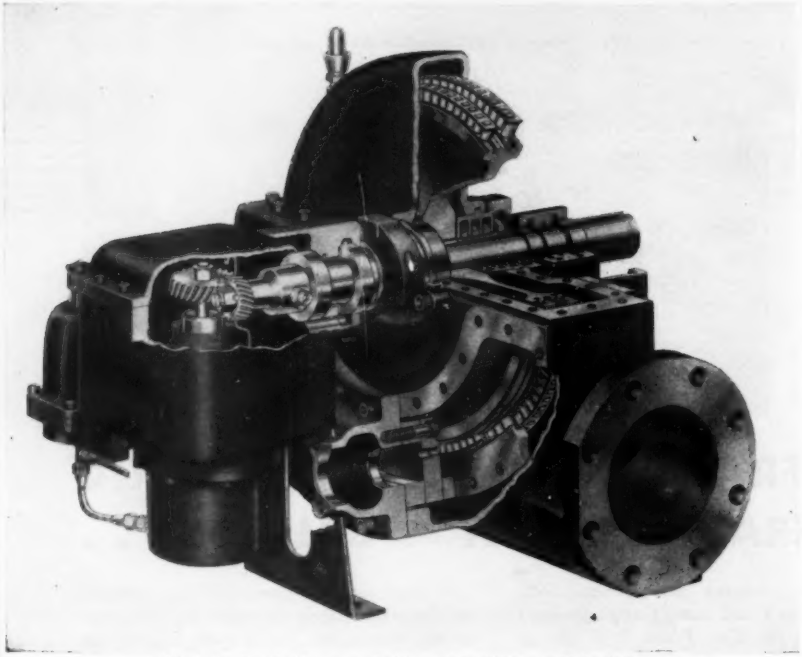
VULCAN SOOT BLOWER DIVISION

Continental Foundry & Machine Company

DU BOIS, PENNSYLVANIA

Now More Than Ever . . .

YOUR BEST TURBINE



DP single-stage turbines are rated from 10 to 1200 hp, 1000 to 5000 rpm

Type

DP

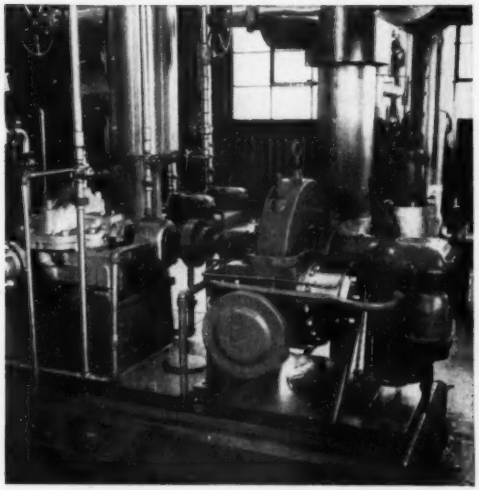
Since the introduction of the DP turbine, more than two years ago, General Electric has been telling mechanical-drive turbine users that their best turbine buy was a *standard* design, wherever it could be properly applied. Nowadays, with the emphasis on increased output, the advantages which turbine standardization offers are even more important.

Standardization means that turbines of different rating and size have mostly identical construction features. This speeds delivery, cuts manufacturing costs, makes possible a better design and a better turbine. If you're not familiar with the General Electric DP, we suggest that you contact your nearest G-E sales office or send for a copy of bulletin GEA-4955, "A New Standard in Mechanical Drive Turbines." Write to *Apparatus Dept., General Electric Company, Schenectady, N. Y.*

GREATER RELIABILITY

From its totally enclosed governor to its durable babbitt-faced bearings, General Electric's DP turbine is built to provide greater productivity through greater reliability. Standardization has made possible "extras" such as pressure lubrication, Monel-sprayed shaft, self-positioning packings, a totally enclosed hydraulic governor. You can count on your DP for safe, dependable service in hazardous atmospheres and on tough, continuous-process assignments.

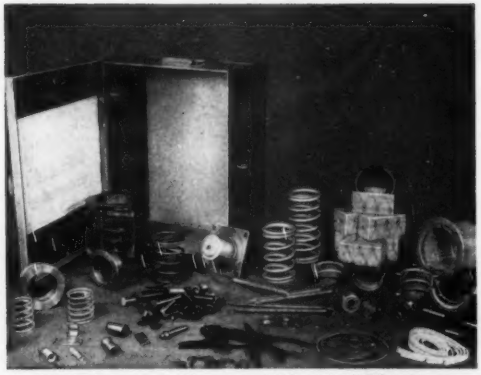
DRIVE IS A STANDARD



This DP drives a centrifugal pump in a refinery

WIDE APPLICATION FLEXIBILITY

In plants which require shifting of equipment from job to job, a standard DP frequently eliminates the need for extra drives. Because most parts are identical for all ratings, speed range and shaft horsepower can be easily and economically changed to fit new conditions. Though the DP's 30% adjustable speed range is usually adequate, a new range can be set anywhere from 800 to 5000 rpm simply by substituting a new emergency governor and governor gears. A change in horsepower rating usually requires a new nozzle plate and a few valve parts. These parts are all available on immediate delivery and save the expense of a new turbine which would be required with a less flexible, non-standard unit.



Standard spare parts kits are available with all DP turbines

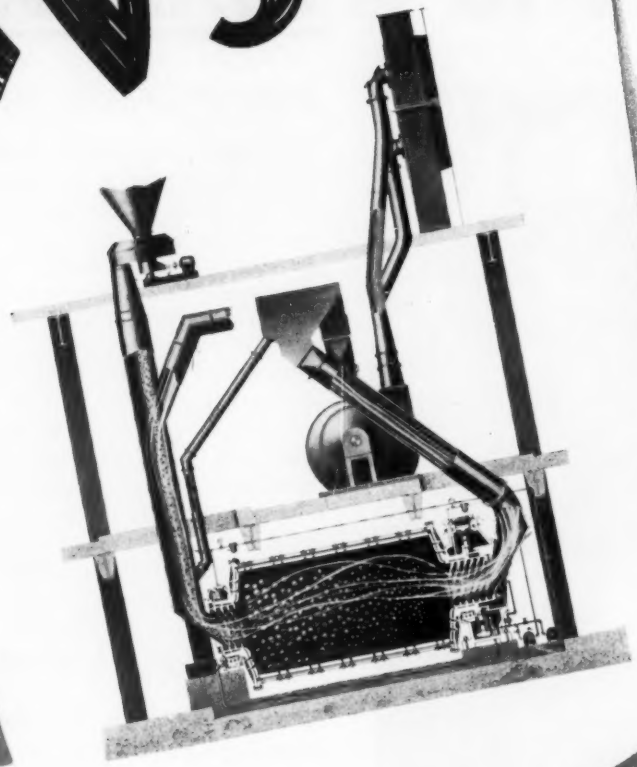
EASIER, QUICKER MAINTENANCE

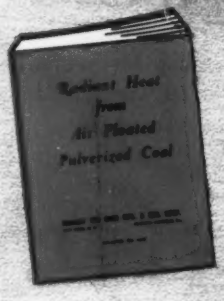
Because most parts of standard DP's are interchangeable on all models, spares can be easily stocked, and maintenance work handled quicker. You can have delivered with the turbine a 91-item spare parts kit, sufficient to service several machines. Socket-head cap screws are used throughout for quick disassembly. Standard shaft height, keyways, and coupling fits simplify installation. You can move DP's from job to job without change in the base structure.

GENERAL ELECTRIC

253-49

KVS AIR SWEPT





Send for a copy of Engineering Bulletin No. 44-B containing valuable information on the preparation of pulverized fuel and steam generation.

TUBE MILLS

provide fuel pulverized to SUPER fineness at lower cost

All grades of coal . . . bituminous, anthracite, coke breeze . . . are prepared for combustion in KVS Pulverizers at low power and maintenance costs. A superfine, completely carbureted fuel is floated out of the mill ready for the combustion chamber.

Fine pulverization results from the hammer-anvil effect of thousands of blows per minute on coal particles against XX Herculite Steel mill liners. Ball wear is almost negligible, contributing to low overall operating cost.

Actual experience discloses an availability of approximately 99% with KVS Air Swept Tube Mills, another factor in assuring low cost per ton of coal pulverized.

All other components of KVS Steam Generating Units are engineered to meet specific operating conditions on available fuels for high operating efficiency and maximum economy at all boiler ratings.

KVS is equipped to design and build complete power plants in any part of the world and assume responsibility for overall performance guarantees of all equipment, mechanical as well as electrical.

Kennedy-Van Saun

MANUFACTURING AND ENGINEERING CORPORATION

2 PARK AVENUE • NEW YORK 16, N. Y.

FACTORIES: DANVILLE, PA.

CANADA • ENGLAND • FRANCE • AUSTRALIA

"WE WERE LOSING 5 KILN MOTORS PER MONTH UNTIL WE CHANGED TO FUSETRON dual-element FUSES."

Malvin E. Adams.
Electrician

OZARK HARDWOOD COMPANY

PHONE 252

JOE B. MILLS, MANAGER

CLARKSVILLE, ARKANSAS
April 20, 1950

Bussmann Manufacturing Co.

St. Louis, Missouri

Dear Sir:

I have found a great savings in your Fuzetrons.

Two and one-half years ago I started changing my Dry Kiln motors to Fuzetron protection. Up until I changed completely I was loosing an average of 5 motors per month which was very expensive. I was having to fuse my motors too heavy to pick up the load, then if something went wrong the fuse were too heavy and held the motor on the line, therefore burning it up.

My Kiln motors are 1½ h.p. 5 amp. I fuse them with 5 amp fuzetron. The fuzetron will hold this starting load and when it picks up I still have motor protection if anything goes wrong the fuzetron will blow in time to keep the motor from burning up. I fuse my main pannell with 6 - 600 amp. fuzetron. I used to blow fuzes on this until I changed to fuzetron, therefore, taking care of the surging load.

I have approximately 800 h.p. I fuse almost all the plant on fuzetron. My trouble has been very light since changing to fuzetron for motor protection Fuzetron is tops with me.

Yours very truly,

Malvin E. Adams

Malvin E. Adams
Electrician

FUSETRON

TRUSTWORTHY NAMES IN ELECTRICAL PROTECTION

BUSS

Fusetron DUAL ELEMENT Fuses

Give 10 Point Protection

1. ★Protect against short circuits.
2. Protect against needless blows caused by harmless overloads.
3. Protect against needless blows caused by excessive heating — lesser resistance results in much cooler operation.
4. Provide thermal protection — for panels and switches against damage from heating due to poor contact.
5. Protect motors against burnout from overloading.
6. Protect motors against burnout due to single phasing.
7. Give DOUBLE burnout protection to large motors — without extra cost.
8. Make protection of small motors simple and inexpensive.
9. Protect against waste of space and money — permit use of proper size switches and panels.
10. Protect coils, transformers and solenoids against burnout.

★ Fusetron Fuses have high interrupting capacity as shown by tests of the Electrical Testing Laboratories of New York City in December 1947.

What is the FUSETRON Dual-Element FUSE?

A fuse link combined with a thermal cut-out — the result, a fuse with tremendous time-lag and much less electrical resistance.

They have the same degree of Underwriters' Laboratories approval for both motor-running and circuit protection as the most expensive devices made.

Made to same dimensions as ordinary fuses, FUSETRON Fuses fit all standard fuse holders.

Obtainable in all sizes from 1/10 to 600 ampere, both 250 and 600 volt types. Also in plug types for 125 volt circuits.

Their cost is surprisingly low.

Fusetron is a trade mark of Bussmann Mfg. Co., Division of McGraw Electric Co.

Don't risk losses in your plant!

One **lost** motor,
One **needless** shutdown,
One **destroyed** panel or switch,
One **burned out** solenoid —
May cost you more than replacing every ordinary fuse with a FUSETRON dual-element fuse.

Bussmann Mfg. Co., University at Jefferson, St. Louis 7, Mo. (Division McGraw Electric Co.)

Please send me complete facts about FUSETRON Dual-Element FUSES.

*Name*_____

*Title*_____

*Company*_____

*Address*_____

*City*_____ *State*_____ 351

There's a C-E Stoker that meets your needs exactly

There is no such thing as an "all purpose" stoker. Each type has advantages that are fully realized only when matched with coals of definite characteristics under well-defined operating conditions.

The importance of getting the *right* stoker is readily seen when you consider that the price you pay for it is only a down payment on the continuing cost incident to steam generation. Why? Because the cost of fuel burned every year throughout the useful life of the equipment far exceeds the original purchase price of the stoker. And, at today's coal prices this fact is of paramount interest to you.

Although the complete line of C-E stokers includes seven basic designs, one of the three types shown on the opposite page will prove to be most suitable in 4 out of 5 installations. Each of these stokers represents an outstanding value in its respective field. Each reflects the practical knowledge of fuel and operating conditions Combustion has gained through 65 years experience in stoker design and application . . . with more than 20,000 installations above residence size.

You can assure yourself of top stoker performance by coming to C-E – stoker headquarters – the next time you are in the market. Since C-E engineers have at their disposal every type of stoker equipment they can afford to be completely impartial in recommending the installation which fits your needs *exactly*. B-408

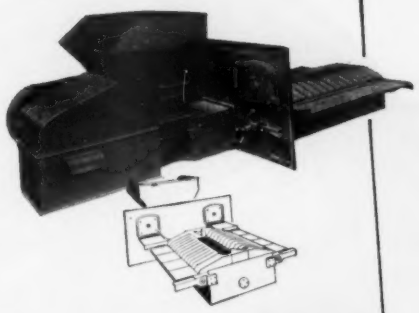
COMBUSTION ENGINEERING

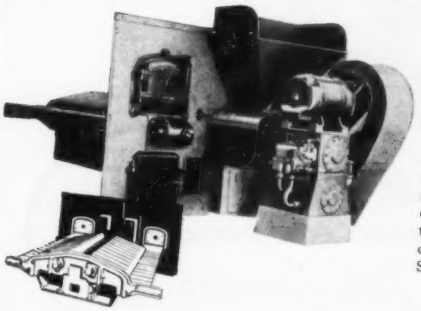
ALL TYPES OF BOILERS, FURNACES, PULVERIZED FUEL SYSTEMS AND STOKERS; ALSO SUPERHEATERS, ECONOMIZERS AND AIR HEATERS

SKELLY STOKER UNIT

Approximate Application Range—20 to 200 boiler hp.

A compact, self-contained underfeed stoker available in designs for burning either anthracite or bituminous coal. An alternate arrangement of fixed and moving grate bars assures lateral distribution of fuel and maintains a clean porous fire. Cantilever dump grates of non-avalanching type simplify ash removal. An integral forced-draft fan, with inlet control, permits positive regulation of air-coal ratio. Sixteen rates of coal feed through variable-speed transmission. Automatic control is standard equipment. Timken bearing equipped. Alemite lubrication throughout.





TYPE E STOKER

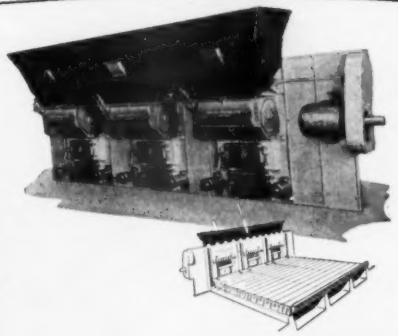
Approximate Application Range—150 to 600 boiler hp.

A single-retort, underfeed stoker designed to burn a wide variety of bituminous coals, particularly those having caking and coking characteristics. The Type E has ram type feed supplemented by a reciprocating sliding bottom. Its grate surface consists of hollow, air-cooled grate bars arranged in an alternately fixed and moving relationship to condition the fuel bed and assure its steady movement to the dump trays which are of the cantilever type. Air supply is under zoned control with provision for introduction of air over the fire. Type E Stokers are available with steam, electric or hydraulic drive.

SPREADER STOKER

Approximate Application Range—150 boiler hp. up to units producing 200,000 lb of steam per hr, or more.

The C-E Spreader Stoker is available in both dumping grate and continuous discharge types. This simple, rugged stoker is designed to burn a wide variety of coals. Hopper, feeding and distributing mechanism, variable-speed drive and motor are combined in a compact unit. Rotating spreader blades feed coal into the furnace in criss-crossing streams which assure uniform distribution. Fines are burned in suspension and the rest of the coal is burned on the grate. Grate surface is zoned for regulating air admission and to facilitate cleaning. All parts subject to wear are readily accessible for inspection, adjustment or replacement, when necessary. Rate of fuel feed and air supply may be regulated over a wide range and are readily adaptable to automatic control.



— SUPERHEATER, INC.
200 MADISON AVENUE, NEW YORK 16, N. Y.
C-E

WESTINGHOUSE
DO NOT LUBRICATE
Life-Line motor
PAIRED FOR PRODUCTION
Life-Linestarter
WESTINGHOUSE

Cut motor failures with these two

Don't take our word for it. Here's what users of Life-Lines say: "We always have had bearing failures on our pump motors. It was quite an expense in repair costs and down time. Since we installed Life-Line motors, we have had no down time . . . no failures. We now standardize on Life-Lines."

Another user reports: "Our former starters employed solder pot mechanisms. Much trouble was experienced. Since we've switched to Life-Linestarters,® our troubles are gone. The operation of the bimetallic disc is positive."

These reports are two of several hundred such reports resulting from the new kind of dependability built into the Life-Line motor and Life-Linestarter.

Life-Line Motors

Steel frame . . . adds strength, cuts weight.
Pre-lubricated bearings . . . no greasing.
Improved windings . . . lengthen electrical life.

Life-Linestarter

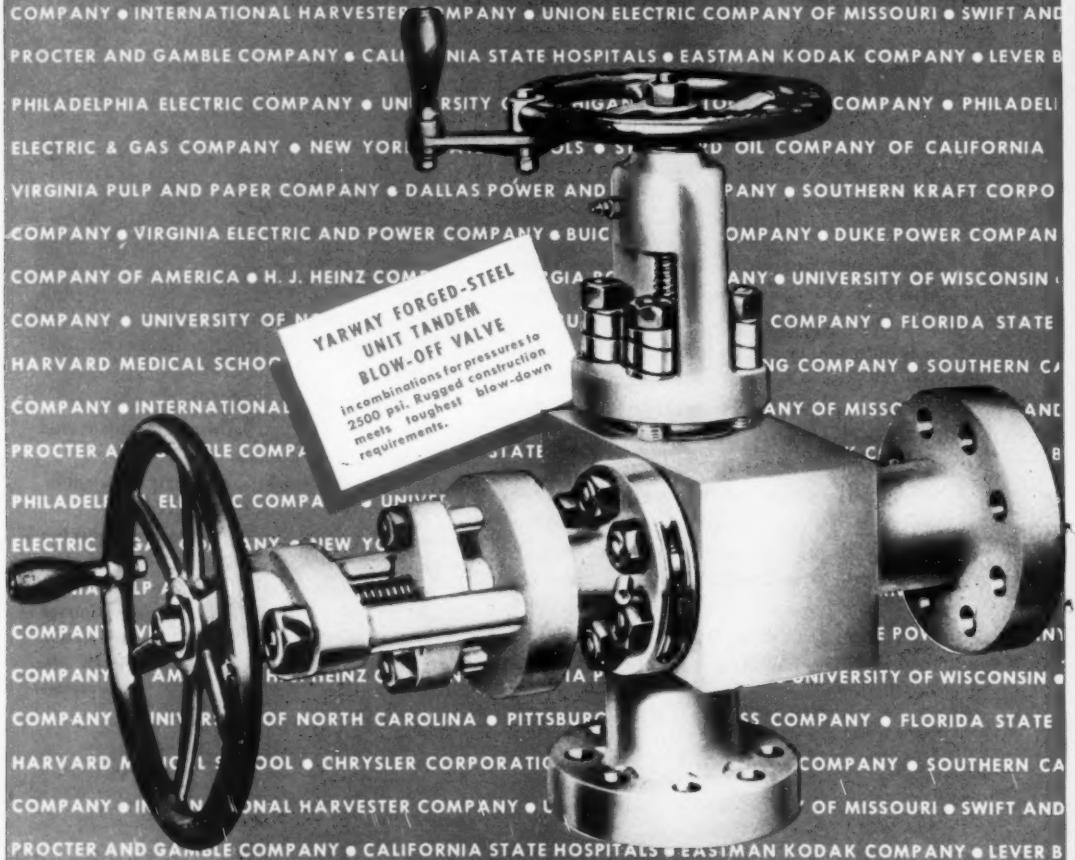
Bimetallic disc . . . calibration unaffected by aging or oxidation.
Servicing is simple . . . all parts removable. Screw driver only tool required.

Get the advantages of these two—your best bet to cut motor failures. Ask your Westinghouse representative for copies of "Life-Line Motor Book", B-3842 and "Tomorrow's Starter Today", B-4677, or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-21644

YOU CAN BE SURE.. IF IT'S
Westinghouse
Life-Line
MOTORS and CONTROLS

A BLOW-

IS KNOWN BY THE


YARWAY FORGED-STEEL
UNIT TANDEM
BLOW-OFF VALVE
In combinations for pressures to 2500 psi. Rugged construction meets toughest blow-down requirements.

YARWAY

HIA PUBLIC SCHOOLS • PACIFIC GAS & ELECTRIC COMPANY • IOWA STATE COLLEGE • PUBLIC SERVICE
BOSTO ANI EST
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• E. I. MPANY UM
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HOSP NY • SITY Y •
LIFO ORPO ATION OF ERI N. O GHT
COMPANY • FLORIDA POWER COMPANY • ARMOUR AND COMPANY • UNIVERSITY OF PENNSYLVANIA •

OFF VALVE BOILERS IT PROTECTS

When buying blow-off valves, weigh the significance of these two facts:

More than 15,000 boiler plants in the United States and other countries are equipped with Yarway Blow-Off Valves... Some of them for nearly 40 years. *Among high pressure plants, 4 out of every 5 in the United States are Yarway-equipped.*

Design, metallurgy, workmanship and service are the reasons. It was Yarway that brought out the famous Seatless Valve, teamed it with a stellited hard-seat valve in a common forged-steel body to make the popular Unit Tandem. Yarway has also made available metallurgical improvements to withstand the chemical reactions of acid wash as well as the mechanical wear of boiler blow-down.

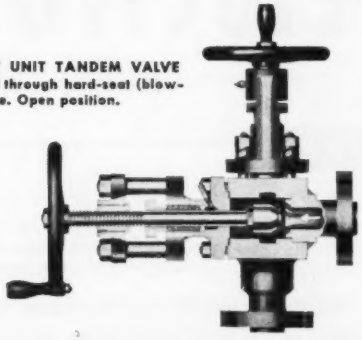
Yarway continues to pioneer and improve blow-off valves and blow-off valve service for both high and low pressure applications.

On new boilers, replacements or modernization, make sure you specify Yarway Blow-Off Valves. Any boiler manufacturer will supply them on your specification.

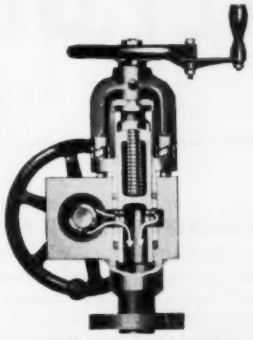
Bulletin B-424 gives you the full story on pressures to 400 psi. Bulletin B-433 for higher pressures. Both are free. Write...

YARNALL-WARING COMPANY, 100 Mermaid Ave., Philadelphia 18, Pa.

YARWAY UNIT TANDEM VALVE sectioned through hard-seat (blowing) valve. Open position.



YARWAY UNIT TANDEM VALVE sectioned through seatless (sealing) valve. Open position.



Presenting the new

REPUBLIC Electronic

FEATURES

NO DEAD SPOTS OR LAGS

The TELEMASTER operates on a null-balance principle with a constant check-back between the initial input and final output, with no intervening mechanisms to cause dead spots or lags. This balance type detection of any deviation in the desired operating conditions, produces a highly responsive and fast acting control system.

ELIMINATES PANEL PIPING

No control panel piping is necessary with the REPUBLIC TELEMASTER. Easily installed, multi-wire cables are the only connection between the TELEMASTER benchboard and the plant measuring and control elements. Results? Easier, faster and better appearing installation, increased flexibility, economy, and reduced maintenance.

GREATER APPLICATION FLEXIBILITY

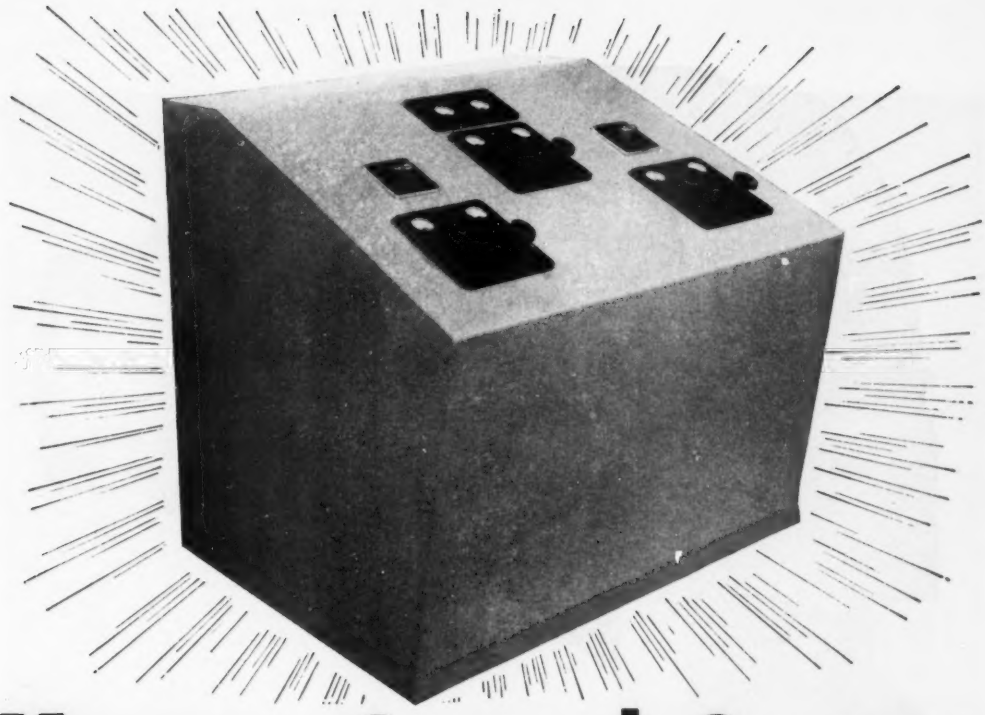
Flexibility required for complete centralization of controls at a central focal point is a distinct feature of the TELEMASTER. The system may be operated under completely automatic, semi-automatic, or manual control from a central supervisory station.

PLUG-IN INTERCHANGEABLE PARTS

Due to simplicity, compactness and interchangeable component parts the TELEMASTER provides a more flexible control system and a more condensed panel area than previously possible. All parts subject to replacement are mounted on compact plug-in units that are easily interchanged and replaced with spare parts.

REDUCED MAINTENANCE

Control room maintenance is sharply reduced. No moving parts or mechanisms are mounted on the control panels. Panel equipment is smaller and less cumbersome, no panel piping is used. Plug-in replacement parts may be installed in a matter of seconds. All components of the TELEMASTER are fully tested and proven for prolonged trouble free service.



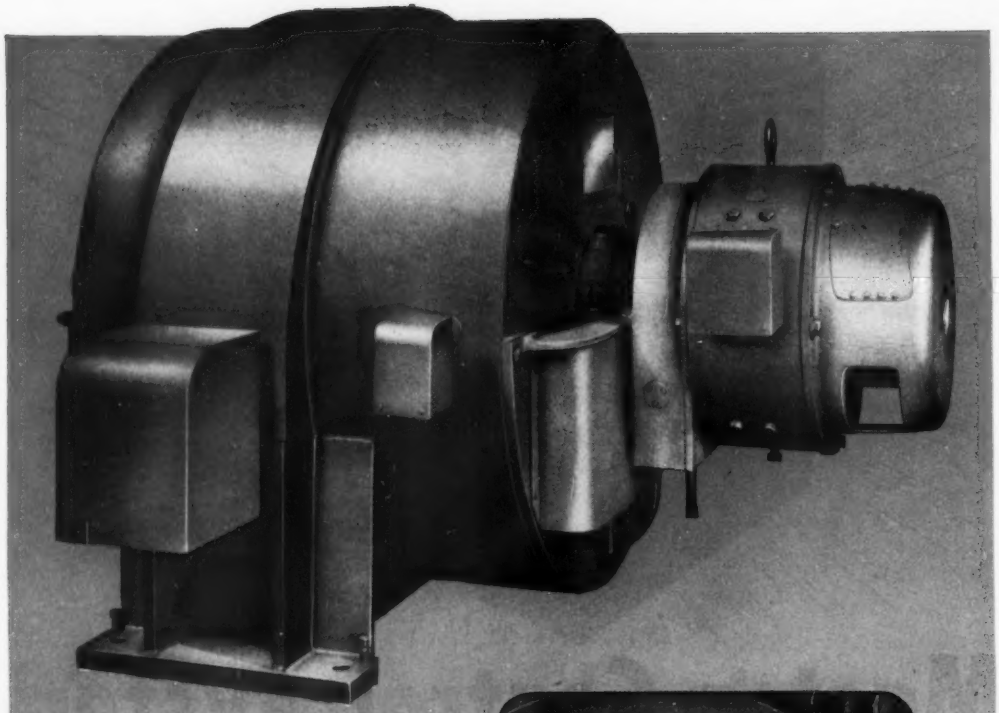
Master Control System

"TELEMASTER"

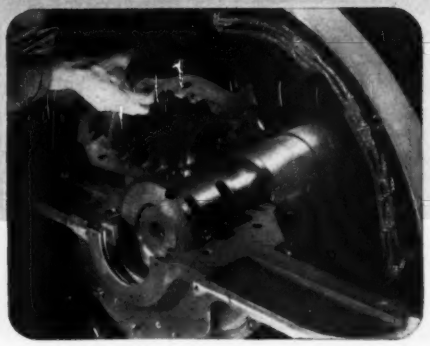
The new Republic Electronic TELEMASTER Control represents a major advance in the field of automatic control. The TELEMASTER will remotely reproduce, instantly and accurately, a position or a force—perform arithmetical and algebraic calculations—and can be used for multiple operations. Essentially it performs the function of a mechanical link through electrical and electronic means. It is applicable to all types of combustion and process control.

In plants where distances between operating units are great, the lags inherent in the compression effect of a pneumatic master system are appreciable. This effect is frequently sufficient to prevent realization of the full benefits of automatic control. The Republic Electronic TELEMASTER Control has no inherent lag, regardless of distance. This means that centralization of operations can be achieved without any sacrifice of control performance. *Full details sent upon request.*

REPUBLIC FLOW METERS CO. ● 2240 DIVERSEY PARKWAY • CHICAGO 47, ILLINOIS



Window makes brush inspection easy. Remove window for quick entrance to brushes . . . for checking and inspection. At a glance you can see operation of brushes on rings.



No top half of bracket to remove—only top half of bearing housing. Lower half is integral with bracket. Bearing can be removed without disturbing bracket mounting. Light, sturdy end covers and air shields are easily and quickly removed. No crane is required. One man can do the job easily.

MORE POWER PER DOLLAR

Synchronous Motor Design Speeds Servicing

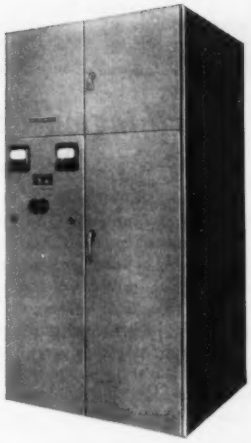
A new kind of maintenance simplicity is built into this line of Synchronous Motors. You can see for yourself in the pictures at the left. Notice the split sleeve bearing housing. Gone is the need for removing the top half of the bracket. Simply remove top half of bearing housing. It can be done by hand. End covers, too, are quickly removed for complete inspection, cleaning, or other servicing requirements. They're light—can be removed by hand.

Brush servicing time is greatly reduced by the window at the collector ring end of the motor. Visual inspection—without disturbing motor—is now possible. When brush replacement is required, simply remove the window and you can get at the brushes without disturbing end brackets or shields.

Considering the ease of maintenance . . . the lower first costs . . . the improvement of power factors, Synchronous Motors supply more power per dollar than any other type of motor. Considering the design features, the fifty years' experience in building motors, Westinghouse offers more motor per dollar.

Ask your Westinghouse representative to show you how Synchronous Motors and Controls can save you money. Call him today, or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pa.

J-10353



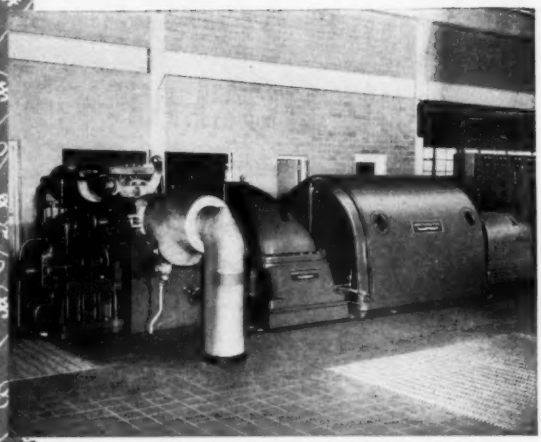
Matched control for the motor. This Slipsyn Synchronous Motor Control protects your motor investment . . . helps you get more for your power dollar.

YOU CAN BE SURE... IF IT'S

Westinghouse

SYNCHRONOUS MOTORS AND CONTROLS

FACTS ABOUT THE *Most Profitable Turbine Generator Investment* YOU CAN MAKE...



One of two Worthington 4000 kw turbine generator sets installed in a mid-western municipal power plant, operating on 600 #G and 750 F.T.T. Steam exhausting to 28" Hg vacuum.

Worthington's Experience and Undivided Responsibility Assure Low Cost, Dependable Power

Builders of steam turbines for over 30 years, Worthington's Steam Turbine Division is backed by the experience and resources of the entire Worthington organization — recognized leaders in the power plant field for more than a century. In view of today's increased turbine pressures and temperatures — and the resulting needs for new and special materials — this vast, combined source of technical knowledge has proved of tremendous practical value in developing turbine design, construction and performance.

Generators Are Worthington's, Too

The generators used with Worthington Turbines are built by a Worthington subsidiary that has specialized in this field for over 45 years. This means that Worthington, as manufacturers of *complete* turbine generator units, assumes *undivided responsibility* for the coordinated design, assembly and performance of these units.

Before shipment, Worthington Turbines and Generators are assembled together *as units* for testing and adjustment — eliminating the necessity for doing this after installation. Also, for installation and service, Worthington turbine specialists and regular Worthington service men are always available from our District Offices throughout the country.

Check These Over!

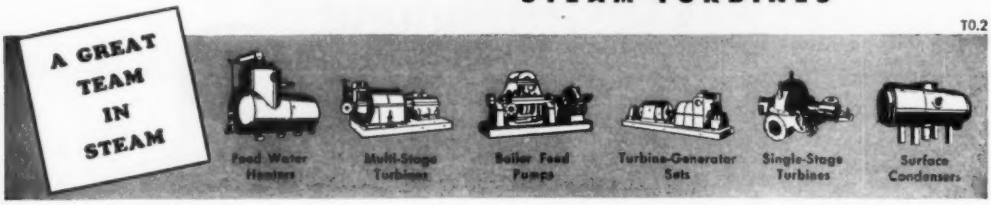
Adding up, Worthington's matchless power plant experience . . . huge manufacturing facilities . . . long specialization in both turbine and generator manufacture . . . undivided unit responsibility . . . and skilled technical service . . . are the best assurance you can get anywhere of efficient, economical steam turbine power.

Worthington makes turbines in a wide range of sizes and types, each one designed to make steam do more work. For details proving *there's more worth in Worthington*, contact your nearest Worthington representative. Or write to *Worthington Pump and Machinery Corp., Steam Turbine Division, Wellsville, N. Y.*

WORTHINGTON

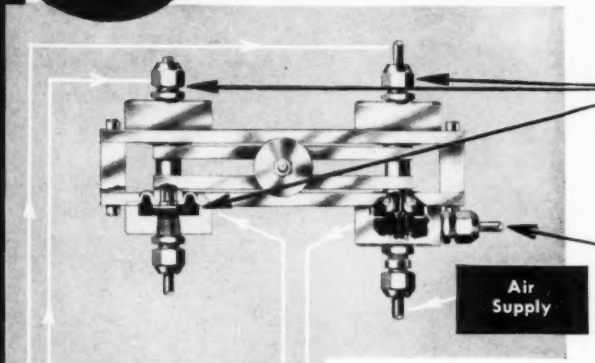
STEAM TURBINES

T0.2



another *FIRST* by HAGAN

HAGAN ratio totalizer



up to 3 input signals combined accurately to give 1 pneumatic output signal

Steam Used by Auxiliaries

Steam Generated by Boiler 1

Steam Generated by Boiler 2

Net Steam Available from Boilers 1 and 2

Here are a few of the things you can do with this versatile automatic control mechanism.

1. Add, subtract or average pneumatic indications of flow rates, to secure a pneumatic indication of the totalized flow.

2. Transmit a pneumatic output signal which is in a definite ratio to a measured static pressure.

3. Establish a remote pneumatic set point adjustment or introduce rate of change or automatic reset characteristics into an automatic control system.

4. Establish a wide variety of selector or limiting control actions by using Totalizer units singly or in multiple.

The Hagan Ratio Totalizer is typical of the constant development of Hagan Control Systems to meet advancing requirements.

Hagan Bulletin 5450 describes the Ratio Totalizer and its operation in detail. To secure a copy of this bulletin, or information concerning any specific application in which you are interested, write to Hagan Corporation, Hagan Building, Pittsburgh 30, Pa.

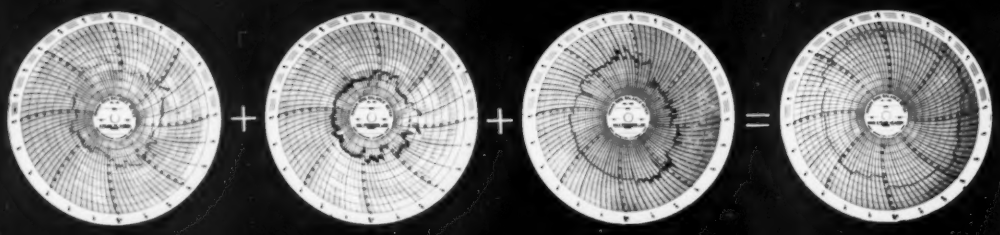
HAGAN CONTROLS

HAGAN CORPORATION

RING BALANCE HAGAN Ring Balance

HAGAN BUILDING, PITTSBURGH 30, PA.

combustion control systems . . . ring balance flow and pressure instruments



Dependable
Steam Records
with
HAGAN
Ring Balance Meters

The steady increase in steam costs makes it more important than ever to have accurate records of steam distribution, so that costs can be allocated properly.

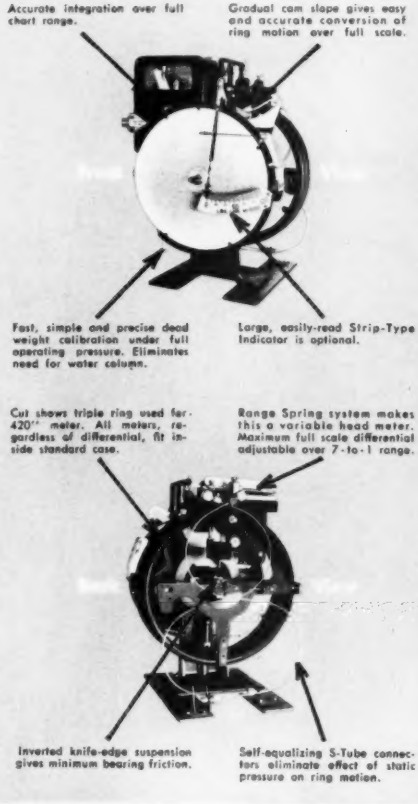
With Hagan Ring Balance Meters, your steam production and distribution records are accurate, and distribution costs can be made on the correct basis. Your records will be reliable over the entire chart range, for Hagan Ring Balance Meters instantly follow all flow changes, from 100% down to zero.

The Integrator totalizes flow automatically, and is accurate over the full scale.

Hagan Ring Balance Meters are available in single or dual models, with or without automatic pressure and temperature compensation, and for full scale differentials from ½" to 420" of water.

For more information about Hagan Ring Balance Meters, write to Hagan Corporation, Hagan Building, Pittsburgh 30, Pa.

Hagan Ring Balance Meter for indicating, recording and integrating fluid flow. Assembly shown is designed for differentials from 280" to 420" WC and pressures up to 1500 psig.


Accurate integration over full chart range.
Gradual cam slope gives easy and accurate conversion of ring motion over full scale.
Fast, simple and precise dead weight calibration under full operating pressure. Eliminates need for water column.
Large, easily-read Strip-Type Indicator is optional.
Cut shows triple ring used for 420" meter. All meters, regardless of differential, fit inside standard case.
Range Spring system makes this a variable head meter. Maximum full scale differential adjustable over 7-to-1 range.
Inverted knife-edge suspension gives minimum bearing friction.
Self-equalizing S-Tube connectors eliminate effect of static pressure on ring motion.

HAGAN

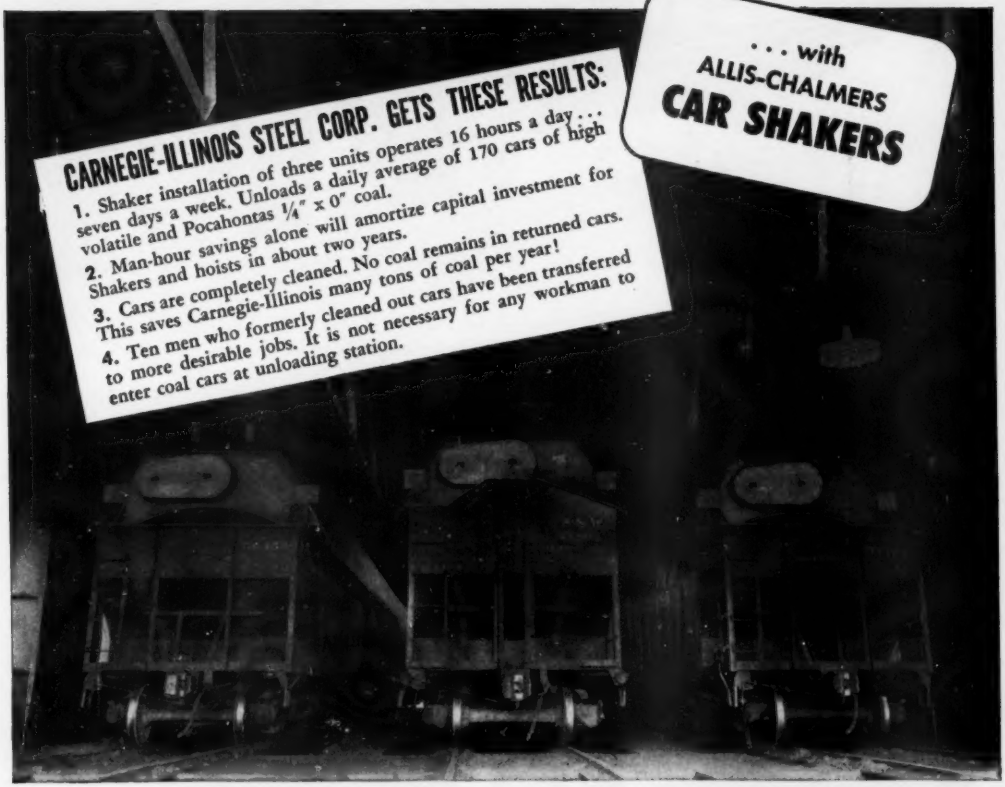
HAGAN
CORPORATION

RING BALANCE HAGAN Ring Balance

HAGAN BUILDING, PITTSBURGH 30, PA.

combustion control systems . . . ring balance flow and pressure instruments

STEEL MILL UNLOADS
170 Coal Cars Daily!


CARNEGIE-ILLINOIS STEEL CORP. GETS THESE RESULTS:
1. Shaker installation of three units operates 16 hours a day . . . seven days a week. Unloads a daily average of 170 cars of high volatile and Pocahontas ¼" x 0" coal.
2. Man-hour savings alone will amortize capital investment for Shakers and hoists in about two years.
3. Cars are completely cleaned. No coal remains in returned cars. This saves Carnegie-Illinois many tons of coal per year!
4. Ten men who formerly cleaned out cars have been transferred to more desirable jobs. It is not necessary for any workman to enter coal cars at unloading station.
. . . with
ALLIS-CHALMERS
CAR SHAKERS

YOU CAN GET SIMILAR SAVINGS in demurrage charges and man-hours by installing an Allis-Chalmers Car Shaker. And you save with safety! Accidents are eliminated as workmen do not have to mount the car during the automatic unloading operation.

The Shaker is driven by a 15 hp, high torque, integrally enclosed Allis-Chalmers motor — mounted on rubber to protect motor from severe vibration.

For complete information on how the Car Shaker can help *you* save time and money, contact your nearby A-C Sales Office. Or write for Bulletin 07B7221.

ALLIS-CHALMERS, 952A SO. 70 ST.
MILWAUKEE, WIS.

Please send Car Shaker Bulletin 07B7221.

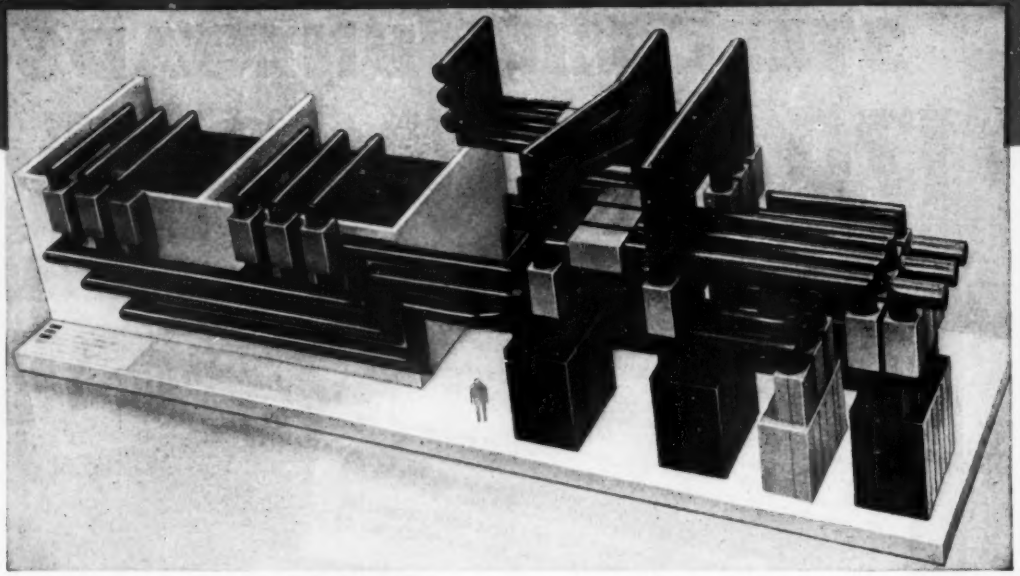
Name .....

Title .....

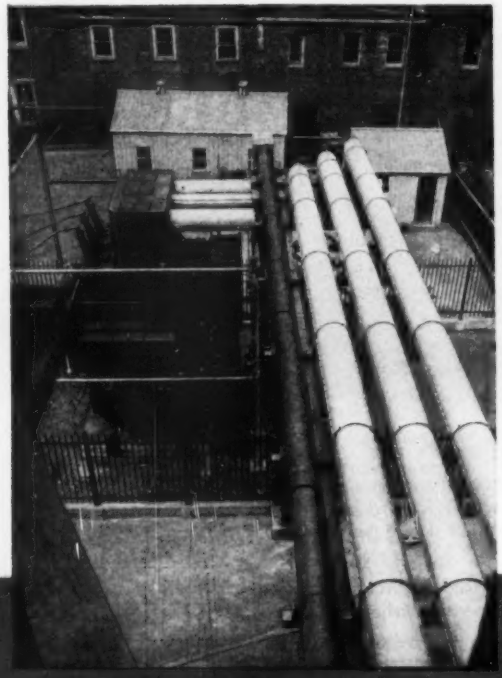
Firm .....

Address A-3171

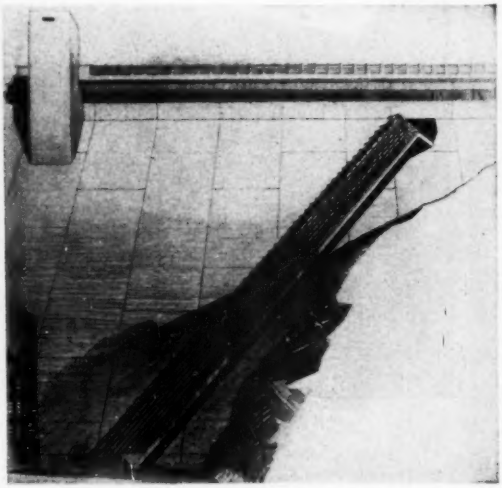
ALLIS-CHALMERS



Scale Model 69 KV Distribution Bus — Consolidated Edison Company



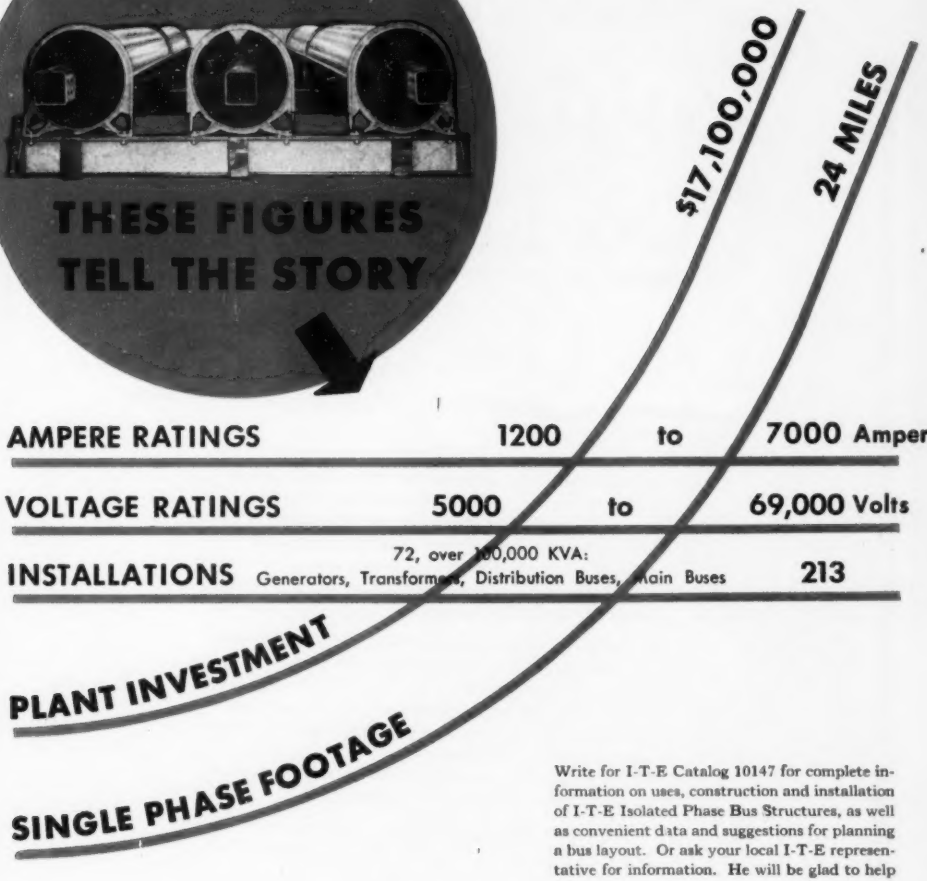
4000 Ampere 13 KV Isolated Phase Bus
Delaware Station, Philadelphia Electric Company



Artist's Conception Grand Coulee Pump Bus
Each bus feeds 2—75,000 Horse Power Synchronous Pumping Motors

First in 1936
...and still
leading the way!

EXPERIENCE?



AMPERE RATINGS	1200	to	7000 Amperes
VOLTAGE RATINGS	5000	to	69,000 Volts
INSTALLATIONS — 72, over 100,000 KVA: Generators, Transformers, Distribution Buses, Main Buses			213

Write for I-T-E Catalog 10147 for complete information on uses, construction and installation of I-T-E Isolated Phase Bus Structures, as well as convenient data and suggestions for planning a bus layout. Or ask your local I-T-E representative for information. He will be glad to help you.

I-T-E

R&IE

ISOLATED PHASE BUS STRUCTURES

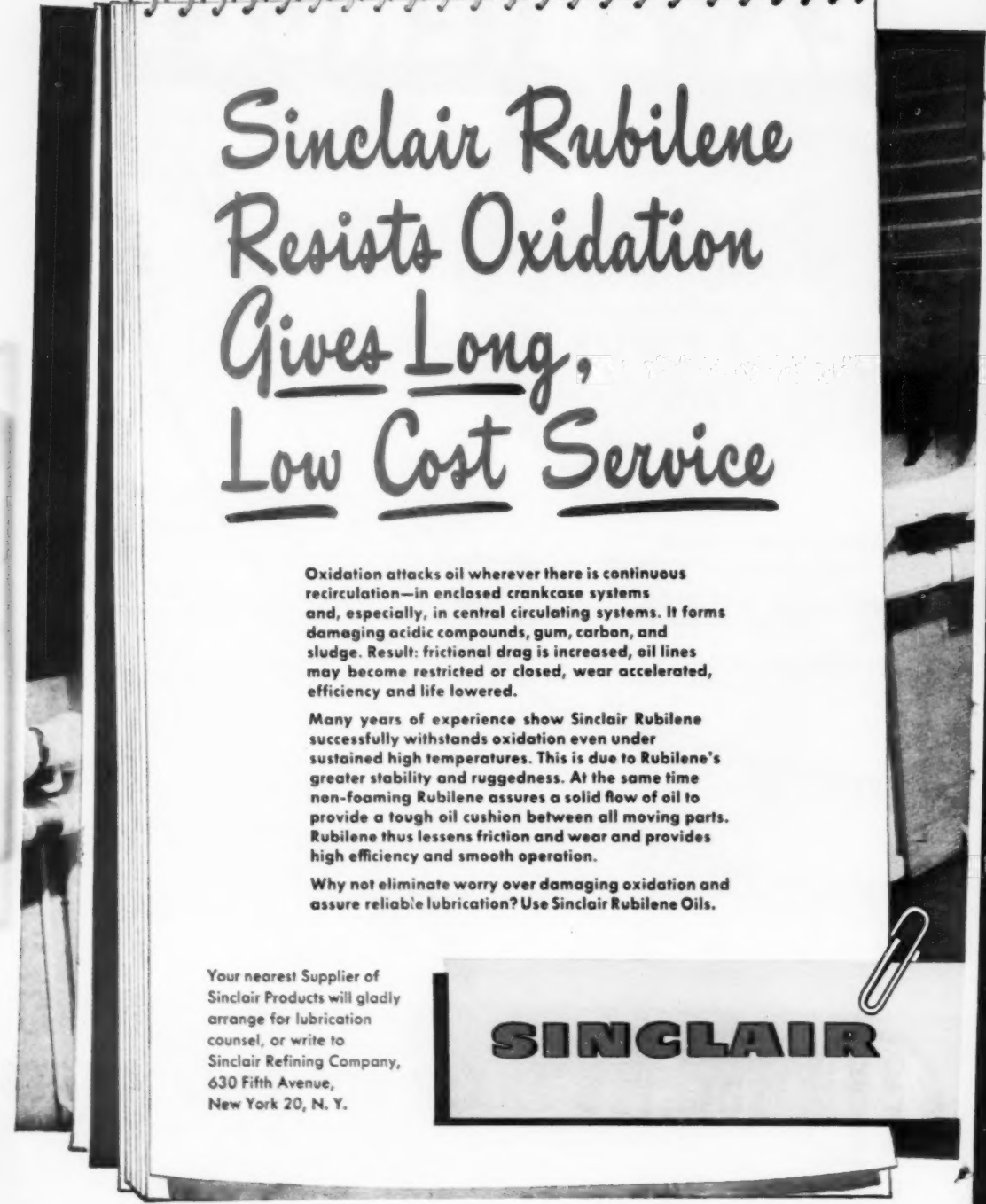
I-T-E Circuit Breaker Company, 19th and Hamilton Streets, Philadelphia 30, Pa.

Power Switching Equipment: Railway and Industrial Engineering Co., Greensburg, Pa.

Canadian Mfg. & Sales: Canadian Power Devices, Ltd., Toronto . . . Export Sales: Philips Export Corp., New York

SWITCHGEAR • UNIT SUBSTATIONS • ISOLATED PHASE BUS STRUCTURES • SURGE DIVERTERS • MECHANICAL RECTIFIERS • VARISTORS • SPECIAL PRODUCTS

Sinclair Rubilene Resists Oxidation Gives Long, Low Cost Service



Oxidation attacks oil wherever there is continuous recirculation—in enclosed crankcase systems and, especially, in central circulating systems. It forms damaging acidic compounds, gum, carbon, and sludge. Result: frictional drag is increased, oil lines may become restricted or closed, wear accelerated, efficiency and life lowered.

Many years of experience show Sinclair Rubilene successfully withstands oxidation even under sustained high temperatures. This is due to Rubilene's greater stability and ruggedness. At the same time non-foaming Rubilene assures a solid flow of oil to provide a tough oil cushion between all moving parts. Rubilene thus lessens friction and wear and provides high efficiency and smooth operation.

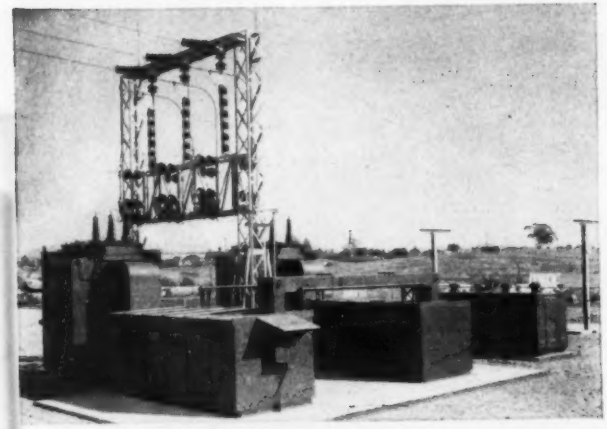
Why not eliminate worry over damaging oxidation and assure reliable lubrication? Use Sinclair Rubilene Oils.

Your nearest Supplier of Sinclair Products will gladly arrange for lubrication counsel, or write to Sinclair Refining Company, 630 Fifth Avenue, New York 20, N. Y.

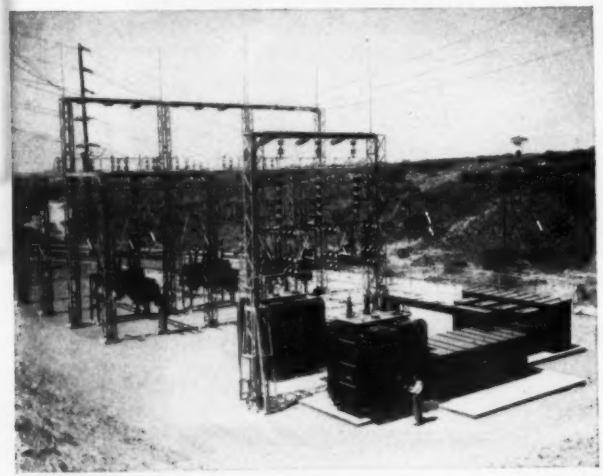
SINCLAIR

Sustained New-Oil Quality
Long Oil Life
Tough Oil– Less Wear
Circulates Freely
INDUSTRIAL OILS

SAN DIEGO GAS AND ELECTRIC
speeds expansion with
PACKAGE SUBSTATIONS



CHOLLAS PACKAGE SUBSTATION, rated 12,000/16,000 kva. Photograph taken from near 69-kv structure shows metal-clad switchgear, 69-kv mounting arresters and horngap switches, and the 125-volt battery house.



WABASH SUBSTATION—constructed completely from packaged equipment, including station structure. This station transforms 69-kv to 4160 volts. Equipment includes two unit substation transformers 5000-kva self-cooled or 6667-kva forced-air-cooled and four 225-kva 3-phase induction voltage regulators operated in triplex.

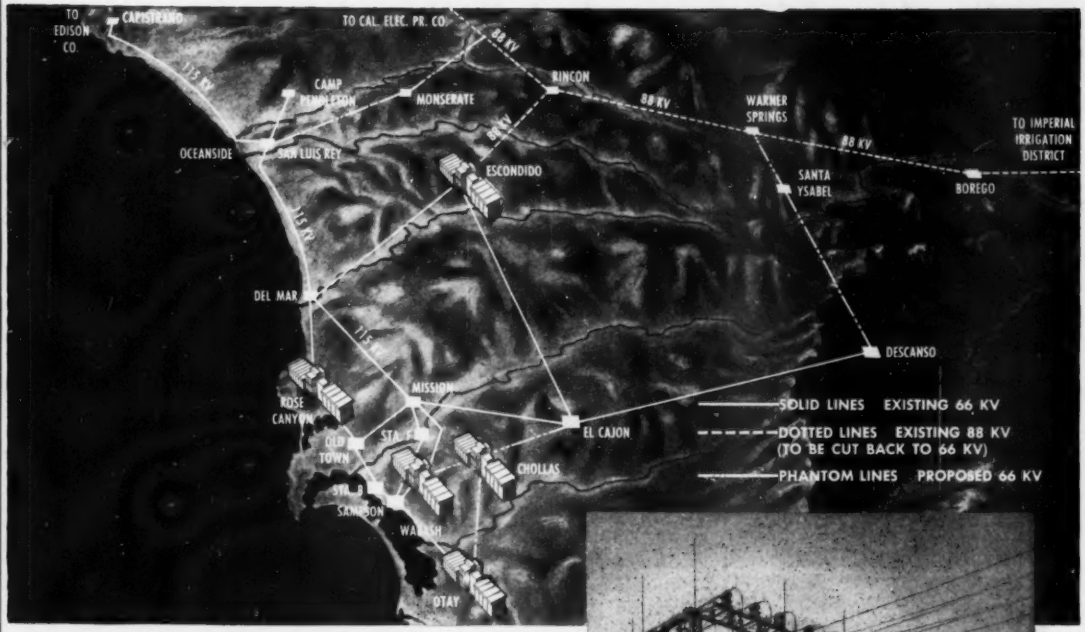
Saves engineering time, simplifies purchasing, speeds delivery to meet tremendous load growth.

Careful planning during the war years enabled San Diego Gas and Electric Company to expand its postwar system with exceptional speed—to meet the huge 350 percent increase in load. Additional generating capacity was the first consideration. But new substation capacity was also urgently needed to relieve badly overloaded equipment and to correct low-voltage conditions on parts of the system. Why did they standardize on **package** substations? Here's what they say:

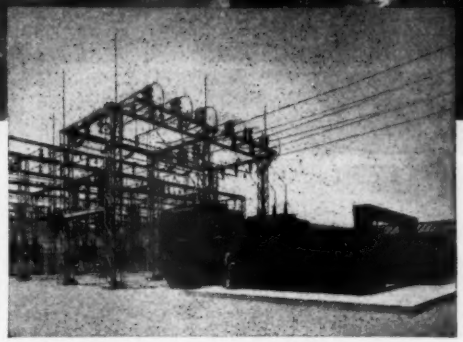
"This method of purchasing minimizes the engineering required since a single set of brief specifications outlining functional requirements is all that need accompany the single purchase order. Ordering all of the equipment from one manufacturer further reduces the engineering time required. It places on the manufacturer the responsibility of co-ordinating all of the various items of equipment and of supplying a workable substation, complete with installation, over-all arrangement, and over-all connection drawings. It frees the utility engineer from the details of co-ordinating and expediting and makes his time available for system planning where he can make more valuable contributions."

These considerations were important to the San Diego Gas and Electric Company. It permitted them, even with a small engineering force, to place orders promptly for complete substations, securing early places in the production schedules.

Apparatus Department, General Electric Company, Schenectady 5, New York.

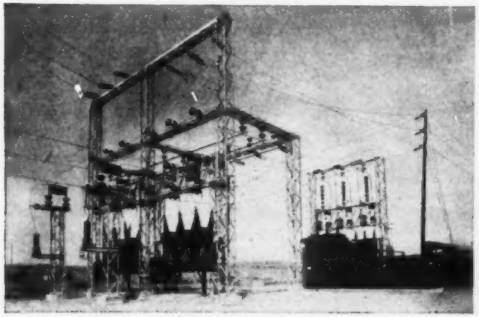


This map shows the planned expansion of the 69 kv transmission system of the San Diego Gas and Electric Co. New package substation locations are shown in red. Substations are functionally similar and made up of standard-design components, the main differences being in secondary voltage and type of regulation. Photographs of the package substations appear on these pages.

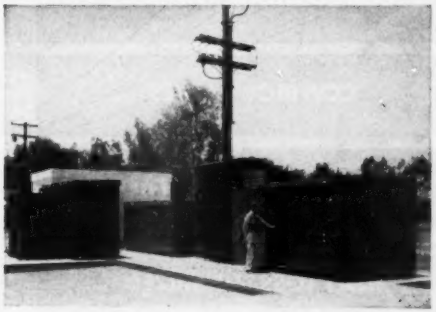


(Above) **ESCONDIDO SUBSTATION,** comprising two 3-phase, 66-kv to 12.47-kv, 6000-kva transformers and complete station structure.

OTAY PACKAGED SUBSTATION, rated 12,000/16,000 kva, transforms 69-kv to 12.47-kv. Photo shows current line traps (left) and large outdoor oil circuit breakers, also at left. At right, the transformers, switchgear, Thyrite* station-type arresters, etc.



(Below) **ESCO PACKAGED SUBSTATION,** including induction voltage regulating equipment and a 3-phase transformer rated 3000-kva self-cooled at 12,470/3,430 volts, Y/2,500 volts.

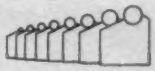
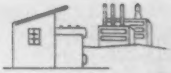


GENERAL ELECTRIC

321-72

*Reg. Trade-mark, General Electric Co.

Combined features that distinguish Foster Wheeler package steam generators

WATER TUBE DESIGN	Vertical tubes,...steady water level, closely spaced waterwall tubes on 3½" centers
FACTORY ASSEMBLED STEAM PLANT	Compact, self-contained steam generating units
WIDE RANGE OF CAPACITIES	7,500 to 30,000 lb per hr . . . flexible multi-unit installations for greater capacities 
HIGH STEAM TEMPERATURES	Provisions for superheaters in some designs
PORTABILITY	May be transported by common carrier . . . minimizes problems of initial installation and plant relocation
EXPERIENCE	50 years' design, engineering, manufacturing of power plant equipment behind each Foster Wheeler unit
EASILY INSTALLED	Simple foundations . . . few service connections
OUTDOOR INSTALLATION	Rugged, steel encased construction 
ACCESSIBILITY	For inspection,...cleaning, maintenance
COMBUSTION CONTROLS	Fully or semi-automatic controls for single or multi-unit installations
CONTROL VALVES	Equipped with 3-valve by-passes
CLEAN HEATING SURFACES	Soot blowers incorporated . . . cleaning without boiler shutdown
HEAT LOSS MINIMIZED	Minimum heat loss—from radiation and air infiltration
RAPID LOAD SWINGS	Large diameter drums and ample furnace heating surface

all for the

price of a PACKAGE

Your operation deserves a *real* steam plant. Today, mounting orders from large and small companies alike testify to the fact that Foster Wheeler Package Steam Generators are supplying industry's answer to the need for a compact, highly efficient source of steam. These units assure economy in the cost of steam production and high availability. They are easily installed and adapted to various fuel and firing arrangements. The Foster Wheeler Package Steam Generator presents a relatively inexpensive way to modernize your plant.

FOSTER WHEELER

For further information, write FOSTER WHEELER CORPORATION • 165 BROADWAY, NEW YORK 6, N. Y.

STRENGTH Plus ACCESSIBILITY

Above is the housing for a "BUFFALO" Double Width Induced Draft Fan under construction, showing how adequately built it is for industry's toughest fan job.

Heavy plate is used throughout, providing an extremely rigid and durable unit. Bolted sectional scroll construction plus refrigerator-type cleanout and inspection doors reduce maintenance. Scroll liners, which protect the inside of the housing from erosion, are readily replaceable. Erosion is further minimized by the inlet guide vanes shown, which also help the efficiency of the fan by cutting down on inlet box losses.

"Buffalo" MECHANICAL DRAFT FANS

"HOUSING PROBLEM"

with "Buffalo" DRAFT FANS!

- HEAVY PLATE HOUSINGS
- QUICK-LATCHING ACCESS DOORS
- SECTIONAL BOLTED DESIGN
- EFFICIENT INLET VANES

Write for your copy!

"BUFFALO", a pioneer maker of mechanical draft fans, has always stressed right housing design. Proper scroll shape for maximum efficiency — heavy metal where heat and erosion hit hardest — "easy-to-get-at" construction — mean cheaper draft service.

Housings are not the only strong points in "BUFFALO" Draft Fans. Bearings are up to the heat and service conditions called for. Rotors are of heavy plate, rigidly braded and dynamically balanced. Shafts are extra large and machined from one piece, thrust collars and all.

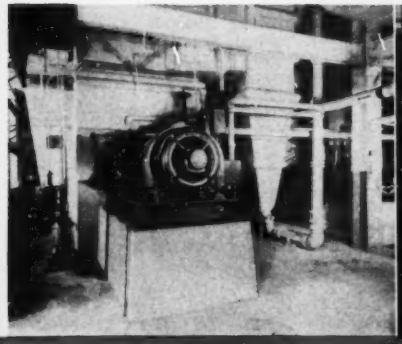
For most satisfactory performance on your draft jobs, specify "BUFFALO", the complete line of forced draft, induced draft, cinder eliminating, sintering, primary air and other dependable fans.

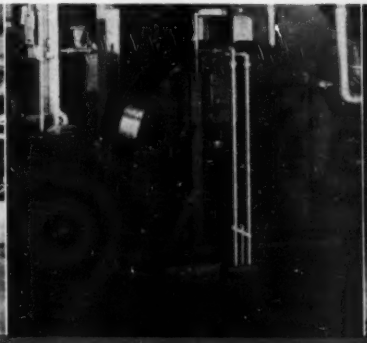
BUFFALO FORGE COMPANY

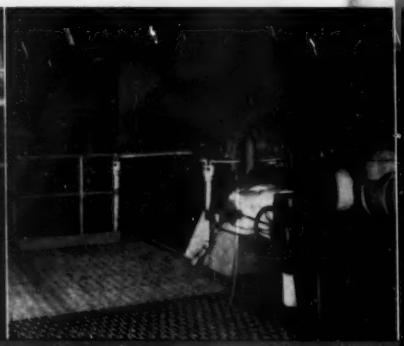
488 BROADWAY — BUFFALO, NEW YORK

Canadian Blower & Forge Co., Ltd., Kitchener, Ont.

Branch Offices in all Principal Cities





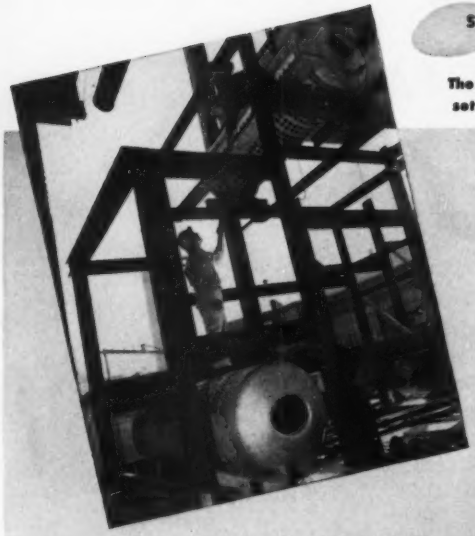


- INDUCED DRAFT
- FORCED DRAFT
- CINDER ELIMINATING

STEP BY STEP, WITHOUT A "STUMBLE"

ELECTRUNITE

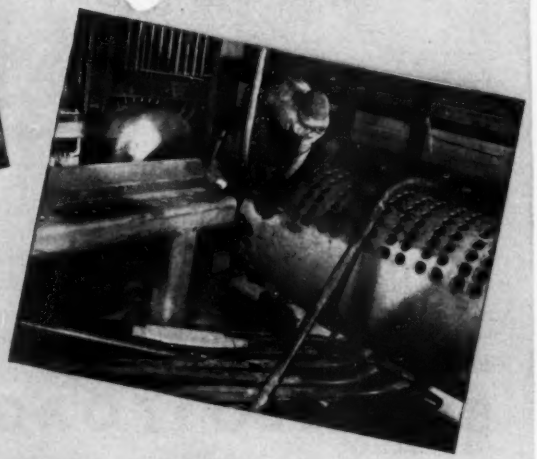
STEP 1



The drums are leveled preparatory to setting in the ELECTRUNITE Boiler Tubes.

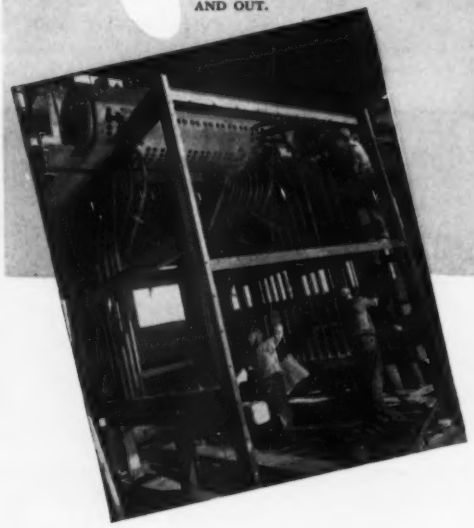
STEP 2

The first tube goes in. A perfect fit! The uniform ductility of ELECTRUNITE Tubing permits prefabrication with assurance of exact fit in any installation.



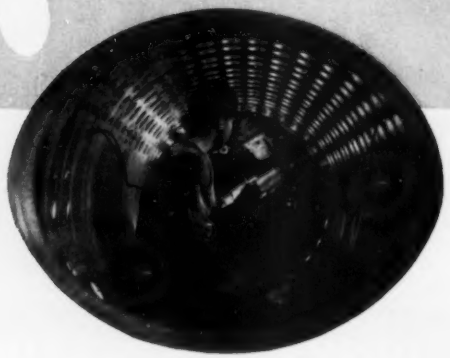
STEP 3

Waterwall tubes go in the header. The flat-rolled steel from which these tubes are made receives close visual inspection on both sides before being cold-formed into tubular shape and electrically welded. ELECTRUNITE Tubing is free from rolled-in scale and scale pits INSIDE AND OUT.



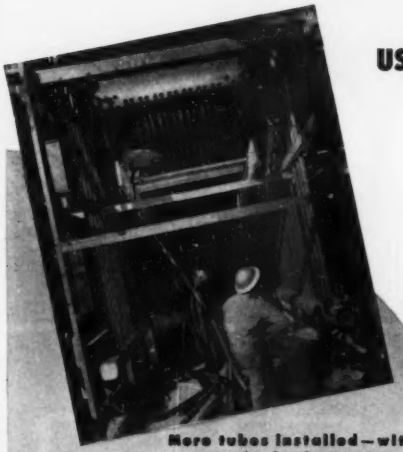
STEP 4

Tube expanding starts. ELECTRUNITE Tubes are Full Normalized their entire length. Cut anywhere, they roller-expand and bead-over to tight, non-leaking joints without annealing.



BOILER TUBES

used in three new Erie City Boilers at Murray-Ohio Manufacturing Co.

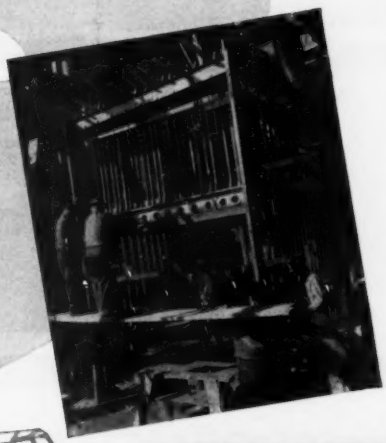


More tubes installed—with spacer strips in place. ELECTRUNITE Tubes are consistently uniform in diameter, wall thickness and concentricity. They slide into tube holes easily and quickly. Records show as much as 30% reduction in installation time with ELECTRUNITE Boiler Tubes.

STEP 5

STEP 6

All the tubes are installed. Workmen are finishing the rolling-in and belling. Here, as in countless other installations, ELECTRUNITE Boiler Tubes have proved their ease of installation. Now, they stand ready to prove their safety and dependability with long, trouble-free service.



Murray-Ohio Manufacturing Company of Cleveland, Ohio is one of America's leading wheel-goods toy manufacturers. Twelve acres of plant facilities turn out wagons, tricycles, autos and other metal toys for youngsters all over the world.

When boilers needed replacing to keep up with plant operations, The Murray-Ohio Company called in the Erie City Iron Works of Erie, Pennsylvania. And, based on past experience, ELECTRUNITE Boiler Tubes were selected for the three new 337 H.P. Erie City 2-drum boilers. Each of these oil-fired boilers is capable of developing 20,400 pounds of steam per hour.

Why not check into the advantages of Republic ELECTRUNITE Boiler Tubes for your equipment? We will be happy to show you how you can profit—on new installations or replacements. Write to:

REPUBLIC STEEL CORPORATION
STEEL AND TUBES DIVISION
CLEVELAND 8, OHIO
Export Dept.: Chrysler Bldg., New York 17, N.Y.

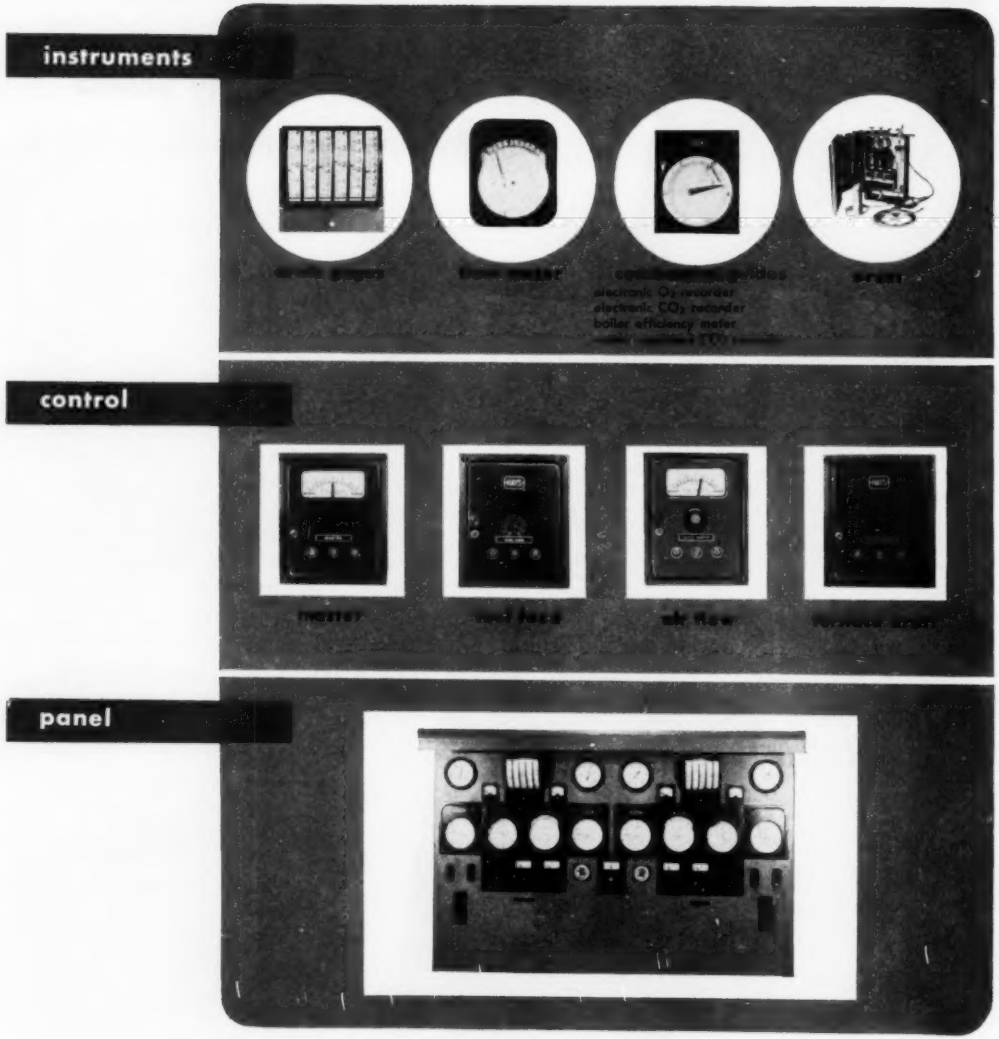
"INTESTINAL FORTITUDE", *a twenty minute movie that pictures the making of modern* ELECTRUNITE *Boiler Tubes is available for group showings . . . Write Republic Steel and Tubes Division if interested.*

Republic REPUBLIC STEEL

ELECTRUNITE

BOILER, CONDENSER AND HEAT EXCHANGER TUBES

This HAYS boiler plant line



can give you *results* like these

Increased efficiency "Our basic reason for installing the Hays electric automatic combustion control was to obtain better efficiency. Our aim was more than reached . . . efficiency has climbed, attaining 79.3%."

Plant Engineer
Manhattan Rubber Div.,
Raybestos-Manhattan, Inc.

Rapid response to wide load swings "We have made test runs using the Hays system, bringing the load rapidly up from 8,000 to 80,000 lbs. per hr. with excellent results. Fuel-air ratio was held at the desired value and CO_2 at 15%."

Chief Engineer of Power Plant
Bemis Bros. Bag Company

Good CO_2 "The (Hays) controls in combination with our instruments make it possible to maintain high efficiency, as indicated by the 14½% average. CO_2 obtained, and keep complete records of our operation."

Chief Engineer
Geo. Ziegler Company

Low maintenance "Our aim has always been to eliminate the need for maintenance wherever possible . . . and we are particularly pleased that maintenance has been 'nil' with the (Hays) automatic combustion control system."

Chief Engineer
Kurth Malting Company

Fuel savings "Our fuel cost per pound of steam has dropped so much since we installed (Hays) instruments and combustion control, that fuel savings alone have been enough to pay for the investment in one year's operation."

Power Plant Chief Engineer
Vollrath Company

Efficiency and savings "The Hays combustion control system has played a large part in enabling us to reduce our fuel bill by 20% as well as to achieve an 81% boiler efficiency rating (by metering tests)."

General Power Engineer
Pullman Standard Car Mfg. Co.

tailored to your specifications

Your conditions are different . . . and Hays engineers tailor the instruments, control and panel to *your* requirements.

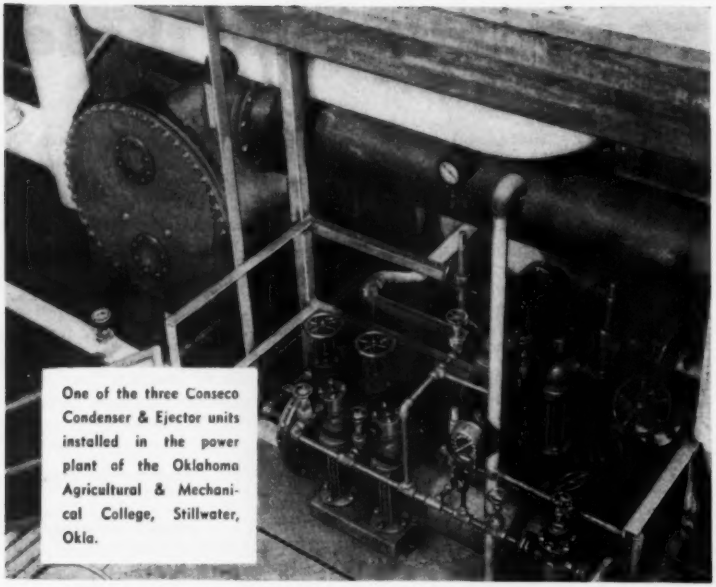
The result? A control system "customized" for your boiler rating, fuel(s), load swings, steam demand, etc. . . . designed to solve the specific problems which plague you . . . with all instruments and controls mounted on a handsome panel laid out, built, and painted according to your instructions.

how to get results

Hays application engineers will provide consultation on the special problems facing your plant. Through careful analysis, working with your actual operating conditions, they will recommend methods to achieve the results you want. Send us a brief statement of your combustion problem for specific preliminary recommendations, without obligation. Ask for Bulletin No. 49-605 and actual case histories of a wide variety of applications.

THE **HAYS** CORPORATION
MICHIGAN CITY 3, INDIANA

Automatic Combustion Control • Boiler Panels • Hays-Penn Flowmeters
Veriflow Meters and Veritrol • Gas Analyzers • Draft Gages
Combustion Test Sets • CO_2 Recorders • Electronic Oxygen Recorders



One of the three Conseco Condenser & Ejector units installed in the power plant of the Oklahoma Agricultural & Mechanical College, Stillwater, Okla.

CONSECO

CLOSED HEATERS

DEAERATORS

OKLAHOMA "AGGIES" INSTALL CONSECO CONDENSERS

Each of these three units, consisting of a two-pass, non-divided flow 2000 sq. ft. Conseco Condenser and a two-stage twin element Conseco Steam Jet Air Ejector, serves a 1500 k.w. turbine.

This installation typifies CONSECO'S ability to meet modern power plant requirements. CONSECO engineers are specialists in heat exchanger equipment and their experience together with CONSECO production facilities are available to assist you in effecting worthwhile savings in furnishing equipment to your specifications. Consult CONSECO on your problem.

BOILERS

EVAPORATORS

REFINER FILTERS

Write for Bulletins covering Ejectors, Evaporators, Condensers, Coolers, Boilers and Pumps.

CONSECO **Condenser Service & Engineering Co.**
HOBOKEN, N. J.

TRI CLAD MOTORS
REG. U.S. PAT. OFF.
will run safely without relubrication for as long as any general-purpose motor you can buy—
and if the application makes relubrication a must, you can grease a TRI CLAD without halting production
GENERAL ELECTRIC
HERE'S WHY

TRI CLAD MOTORS will run safely without relubrication for as long as any general-purpose motor you can buy—

Tri-Clad extra lubrication "protection" can save you money because:

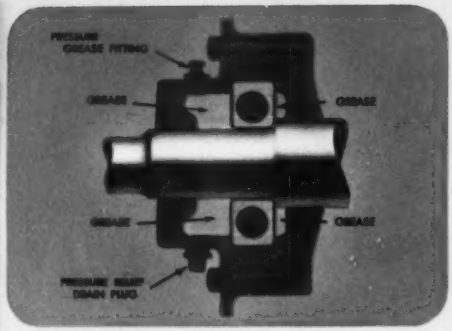
1. Tri-Clad's oversize grease reservoir and the heaviest standard-service bearings mean you do not have to bother with greasing between motor check-ups.

2. When relubrication is needed on those tough applications, you can grease a Tri-Clad without interrupting production-line operations.

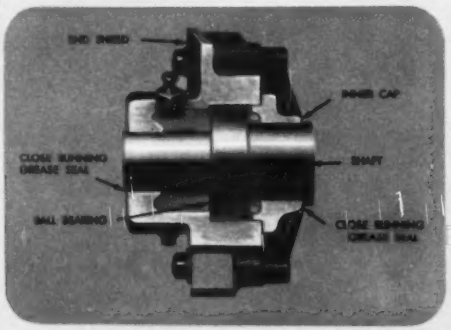
Tri-Clads are grease-gun easy to lubricate *on the job.* Moreover, a Tri-Clad motor will run safely where an ordinary motor would fail. Chances are you'll be spared the cost of a "special" motor.

YOU BE THE JUDGE! The best way to prove to yourself that Tri-Clad gives you the most for your motor dollar is to contact your local G-E office. Tri-Clad stocks are complete. *Apparatus Dept., General Electric Company, Schenectady 5, N. Y.*

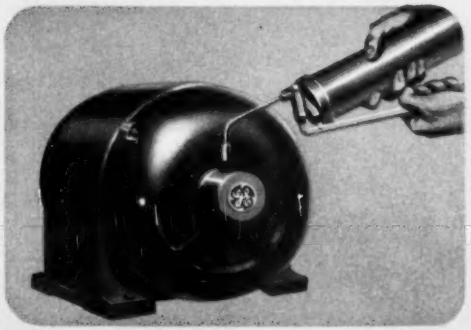
❶ **EXTRA BEARING PROTECTION** — Tri-Clad gives you extra bearing protection because heaviest standard-service bearings are carefully selected to withstand severe loads for long periods.



❷ **EXTRA GREASE** — Four times the ordinary amount of grease is packed into the large Tri-Clad grease reservoir. Since bearing life depends on grease, this means that Tri-Clad motors will run safely for years — for as long as any general-purpose motor you can buy.



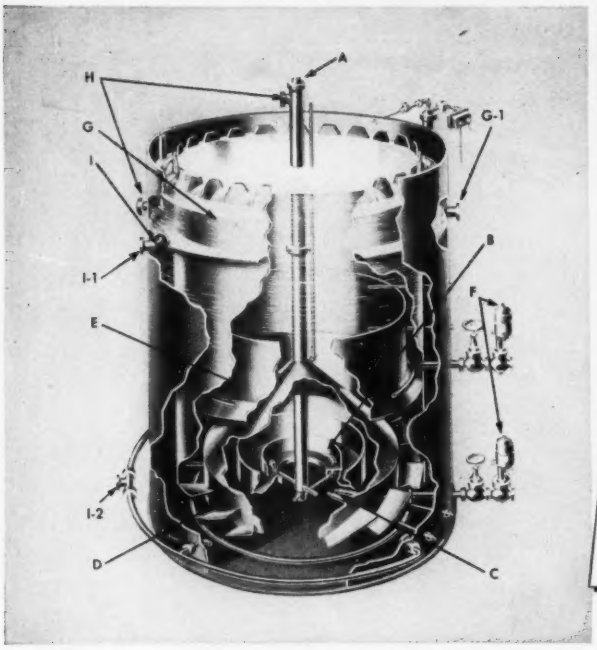
❸ **SEALED-IN BEARINGS** — Bearings and grease are completely sealed in a cast housing with long running seals for extra protection from dirt, dust, and lubricant leakage.



❹ **PRESSURE-RELIEF GREASING** — An efficient system of pressure-relief lubrication (with standard fittings) enables a Tri-Clad motor to be quickly and easily greased on the job when and if it's needed.

GENERAL ELECTRIC

752-3



Vortex mixing eliminates need for submerged moving parts in the Worthington Cold Process Slurry Type Precipitation Water Softener and Coagulator.

REACTION TANK of Worthington Slurry Type Softener (Slurry bed eliminated for clarity). (A) Raw water influent line. (B) Vortexor for optimum slurry production. (C) Chemical Applicators. (D) Slurry bed rotator. (E) Symmetrical Slurry concentrator. (F) Proportionate sludge removal. (G) Collector trough for treated water. (G-1) Treated water effluent. (H) Complementary recirculation. (I) Filter wash water compartment. (I-1) Filter wash water suction. (I-2) Filter wash water return.

This slurry bed stays put!

. . . and troublesome variables are out

These Features Give You The Uniformity You Want

WORTHINGTON SLURRY TYPE PRECIPITATING WATER SOFTENER AND COAGULATOR gives consistent, uniformly softened water

If it's clear, uniformly softened water you want, this unique Worthington Water Softener is just what you need. Concentrated quick mixing and rapid recirculation of applied chemicals and raw water, *achieved by hydraulic energy instead of submerged mechanical moving parts*, is an important, progressive development in the water treatment field.

New Bulletin W-212-B5 gives you 16 pages of vital facts about this unique cold process water softening method. Write for your free copy today.

REMEMBER . . .

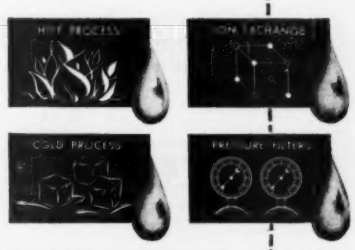
Worthington engineers *all four* water conditioning processes; therefore, can give you unbiased recommendations on which process is right for you . . . further proof that *there's more worth in Worthington. Worthington Pump and Machinery Corporation, Water Treating Division, Harrison, N. J.*

JO.1

WORTHINGTON

WATER CONDITIONING

Worthington Makes More of the Equipment for All Types of Water Conditioning Systems



Power Plant Coal Steps Upstairs...

62 Foot Lift in Restricted Space Via BELT CONVEYORS

On every specification, this S-A Belt Conveyor System meets the individual needs of this coal handling installation—1. Required volume; 2. Operation in a small area; 3. Lowest cost per ton handled. It is designed to handle 50 tons per hour of minus 2" coal.

In its details, this system is typical of the many special-purpose materials handling installations designed by S-A engineers during the past 50 years. Because Stephens-Adamson makes *all* types of bulk conveying equipment, the S-A engineer is able to recommend the most desirable combination of equipment units for the job—*to keep handling costs at a minimum.*

If YOU have a bulk materials handling problem that involves a new or remodelled conveying system, write us today. See what S-A engineers can suggest.

This S-A Belt Conveyor System conveys power plant coal from track hopper and belt feeder to the top of the boiler house—62 feet above track level. The total ground area occupied by the installation is comparatively small. The first belt lifts coal through a coal weighing station. All belt conveyors are covered by steel hoods for protection against the weather. Additional coal can be stored on ground area bounded by the conveyors for later reclaiming to the track hopper.

1901-1951

50 years experience with bulk handling

STEPHEN S-A ADAMSON MFG. CO.

5 Ridgeway Avenue, Aurora, Illinois · Los Angeles, Calif. · Belleville, Ontario

DESIGNERS AND MANUFACTURERS OF ALL TYPES OF BULK MATERIALS HANDLING EQUIPMENT

Save Indoor Space

INSTALL SWITCHGEAR OUTDOORS!

5 kv outdoor metal-clad switchgear with DZ 60 B oil circuit breakers rated 150 mva installed at an east coast utility.

WHEN INDOOR space becomes limited — go OUTDOORS where there's lots of room for future expansion. You save valuable indoor space for other equipment, eliminate expensive building additions or changes.

For outdoor service be sure the switchgear you select is completely steel enclosed to assure reliable operation in any weather—sleet, snow, rain, subzero temperatures and intense heat.

Allis-Chalmers Switchgear is All-Weather Protected: (1) welded-in steel floor plates form a tight bottom seal; (2) overhanging eaves keep out driving rain and sleet; (3) weather proof doors, 3-point latched, close firmly; (4) steel surfaces are phosphate treated prior to receiving multiple coats of weather-tested paint that makes them corrosion and weather resistant; (5) structure rests on 6" base channels; (6) ice and sleet guards protect locks; (7) copper mesh filters furnish protected ventilation.

Allis-Chalmers 5 kv and 15 kv outdoor switchgear is available in ratings from 600 to 2000 amperes, 50,000 to 500,000 kva interrupting capacities. Consult your nearest A-C sales office.

Allis-Chalmers
Milwaukee 1, Wis.

ALLIS-CHALMERS

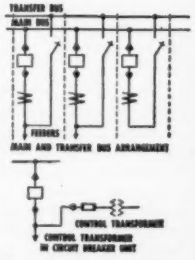
A-3053

VARIED CIRCUIT ARRANGEMENTS

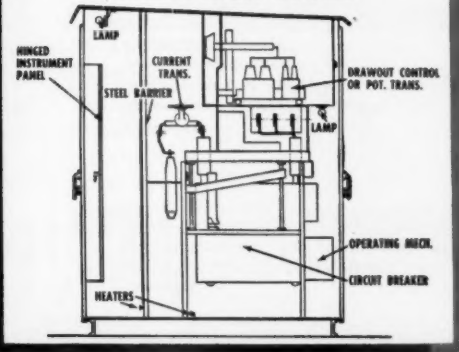
Unique compartment design permits many circuit arrangements in a standard breaker unit. Two typical arrangements are shown:

1. Double bus arrangement with transfer bus and disconnect switch above the main bus compartment. All equipment is easy to get to without extra provisions.

2. Control power transformer arrangement that eliminates the need for an extra auxiliary compartment. Generally used for secondary control battery charging and to supply power for space heaters and lighting applications.



CONSTRUCTION DETAILS



Sweet's File for Power Plants

1 power generating equipment
- steam generating a
- fuel burning b
- prime movers c
- heat transfer equipment d

2 mechanical equipment
- material handling a
- power transmission b
- pumps and compressors c
- pipe and fittings d
- valves and traps e
- instruments and controls f
- miscellaneous equipment and supplies h

3 electrical equipment
- motors and generators a
- controls b

4 materials
- glass c
- thermal insulation d
- refractories e
- roofing and siding g
- waterproofing and dampproofing h
- flooring and wall covering i
- paints and finishes J

5 structural equipment
- structural systems a
- doors and hardware b
- skylights and ventilators c
- partitions, fences and guards d
- chimneys f

6 plant utilities
- water conditioning and sewage disposal a
- air conditioning and refrigeration b
- lighting c

7 special services

looking for mechanical equipment?

A TIP ON FILING LOOSE CATALOGS. A good filing system must be a good finding system. Research and experience in making manufacturers' catalogs quickly and easily accessible have resulted in the improved classification systems now used in the various Sweet's Files. You may wish to use the classification system illustrated here for filing, and easily finding, individually received catalogs, specification sheets, detail drawings, technical articles, etc. In this way, too, ideal coordination can be achieved between file drawer and the catalogs pre-filed in your Sweet's File for Power Plants.

reach for Sweet's . . . **all these manufacturers' catalogs — containing comprehensive information on material handling, power transmission, pumps and compressors, pipes and fittings, valves and traps, instruments and controls, electric motors and generators, and related miscellaneous equipment and supplies—are instantly available in Sections 2 and 3 of your Sweet's File for Power Plants.**

The other sections of this Sweet's File contain additional manufacturers' catalogs covering a wide range of materials and equipment. You will find useful and up-to-date information on product forms, characteristics, performance and use.

This grouping of manufacturers' catalogs, in sections according to products or use of products, is made for your convenience, so that you can more readily compare one product with another. Indexes of manufacturers, products and trade names lead you quickly and easily to the catalogs you are looking for.

Sweet's is working constantly to get more manufacturers to send you their catalogs in this easy-to-use form. If you fail to find what you want in your Sweet's File, please tell us.

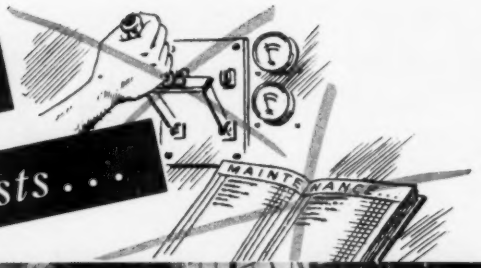
Sweet's catalog service

DIVISION OF F. W. DODGE CORPORATION

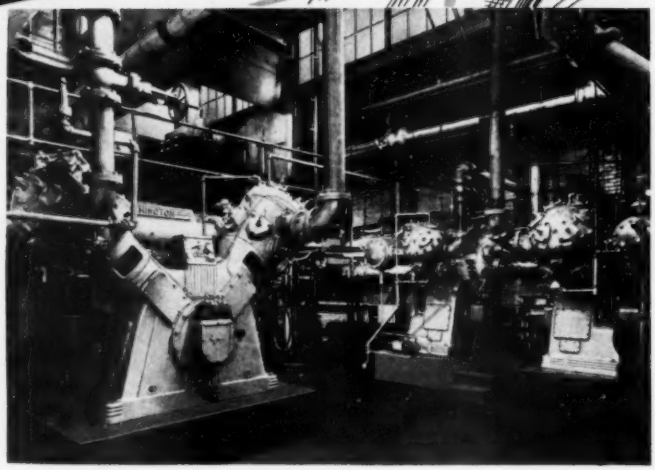
119 WEST 40th STREET NEW YORK 18, N. Y.

No Shutdowns . . .

No Repair Costs . . .



IN 30 MONTHS OF STEADY OPERATION!



Three Worthington YC-2 Compressors on general air service in the Reo Motors Company Plant, Lansing, Michigan. Two of these units ran for 2½ years, the other (a later installation) for 2 years, before all three had their first routine examination. During that time they operated approximately 16 hours per day, 5 days per week, without a single shutdown for maintenance.

Worthington YC-2 Compressors Provide Reo Motors Plant With Trouble-Free, Low-Cost Air Service

Freedom from maintenance worries is just one of the many advantages you get with Worthington YC-2 Compressors. Installation is quick, easy and inexpensive. A YC-2 comes completely assembled — there's no alignment problem and you don't need an erecting engineer. Requiring only half the space and one-quarter the foundation of same-capacity horizontals, it's ready for work as soon as connections are completed — at big savings in time, labor and money.

You get steady savings on operating costs, too, thanks to advanced features like the balanced Y-frame for higher rpm . . . the power-thrifty, instantly responsive 3 and 5-step variable capacity control . . . and Worthington Feather* Valves, most efficient and economical ever made.

GET ALL THE FACTS

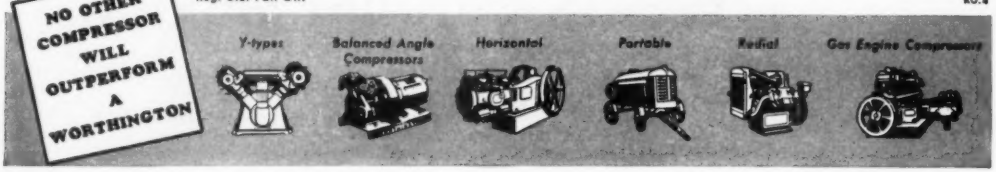
on how YC-2's can cut your air costs — from the first day on! Bulletin L-667-B1A gives you the whole economy story with further proof that *there's more worth in Worthington*. Write to *Worthington Pump and Machinery Corporation, Compressor Division, Buffalo, New York.*

WORTHINGTON

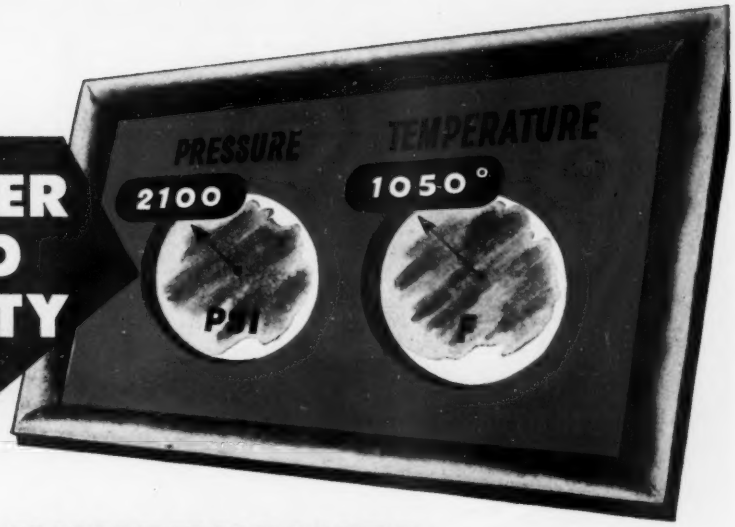
*Reg. U.S. Pat. Off.

K0.4

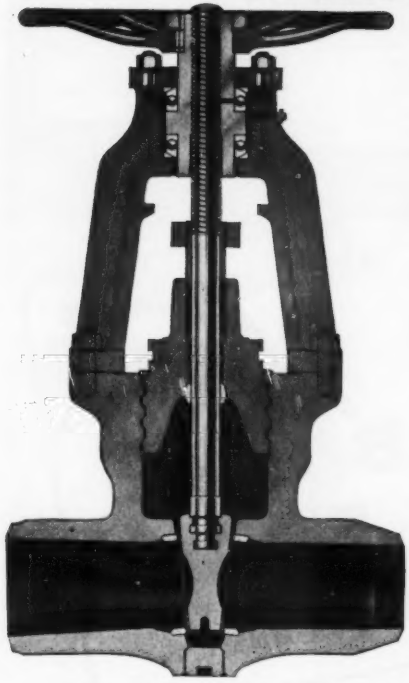
NO OTHER COMPRESSOR WILL OUTPERFORM A WORTHINGTON



POWER AND SAFETY



WITH LUNKENHEIMER



VENTURI OR FULLWAY ENDS

1500 LB. CAST-STEEL BREECH LOCK GATE VALVE

Breech Lock Valves

Your high-pressure, high-temperature lines are *safely* controlled with leak-proof Breech Lock steel valves, rated at 1500 lbs. S.P. and used in central power stations at pressures up to 2100 lbs. at 1050°F. The exclusive Breech Lock design follows the principle used on large guns, except that locking is not accomplished by a thread wedging action. Rather, four series of three heavy annular lugs on the body and in the bonnet intermesh and lock the two parts together. Stress is evenly distributed and the full internal pressure acting against the bonnet is carried by the breech lugs. Pressure tightness is maintained by sealing the seam or joint with a seal weld, which can be chipped out to remove the bonnet, if necessary.

The combination of locking lugs and seal weld possesses a strength and structural stability not attainable in any type of construction that must depend on some form of gasket for pressure-tightness. *Leakage is impossible, and maintenance never required.* In effect, the Breech Lock with Seal Weld has all the advantages of the Strength Welded Bonnet design, plus the added advantage of easy disassembly and reassembly in the field.

NOTE THESE ADVANTAGES:

Eliminates bonnet-joint leakage under the most severe operating conditions. No maintenance required. * Provides for ready disassembly and reassembly in the field. * Bonnet-joint tightness unaffected by rapid temperature changes. * No sealing surfaces to become damaged by corrosion, oxidation, or in disassembly, and thus prevent reassembly of a pressure-tight joint. * No flanges, gaskets, or bolts that will require periodic maintenance attention. * Seal weld makes a leak-proof joint. * Compactness of design reduces weight and bulkiness. * Contour of body and bonnet lends itself to good foundry practice, resulting in sound, dense castings.

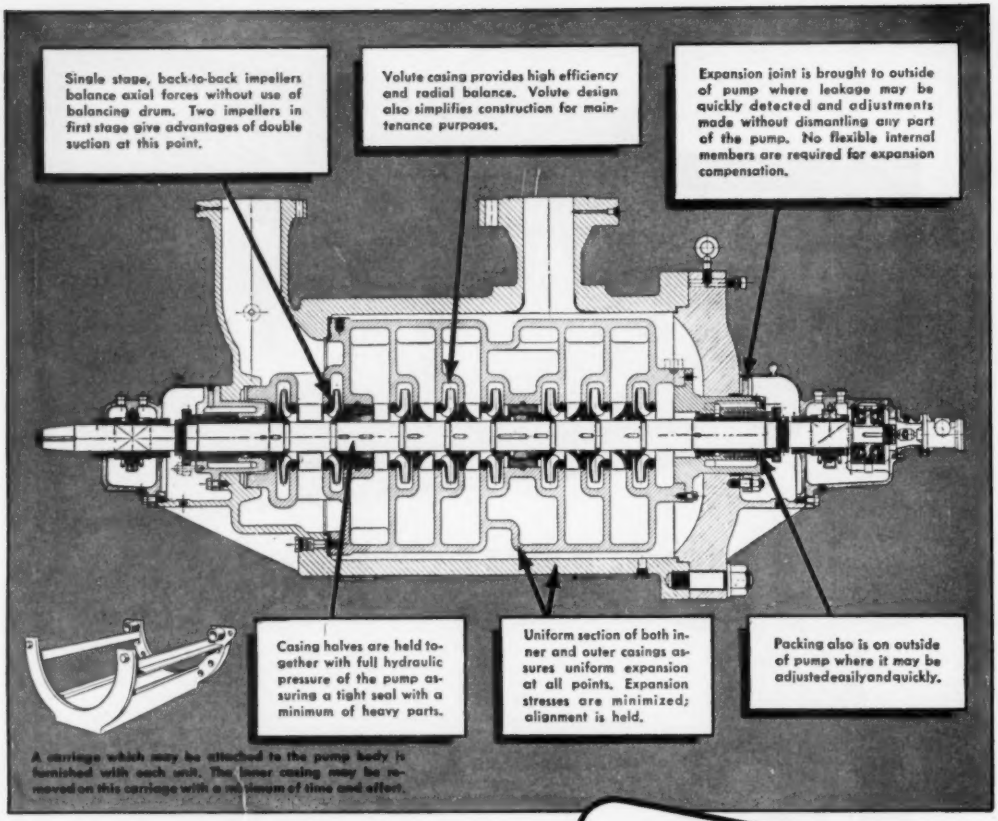
Write for your copy of "Lunkenheimer Cast Steels," a brochure describing basic research in alloys for high-pressure, high-temperature valves. Address: The Lunkenheimer Company, Box 360A, Cincinnati 14, Ohio.

STEEL • IRON • BRONZE

LUNKENHEIMER

THE ONE *Great* NAME IN VALVES

L-151-56


Single stage, back-to-back impellers balance axial forces without use of balancing drum. Two impellers in first stage give advantages of double suction at this point.
Volute casing provides high efficiency and radial balance. Volute design also simplifies construction for maintenance purposes.
Expansion joint is brought to outside of pump where leakage may be quickly detected and adjustments made without dismantling any part of the pump. No flexible internal members are required for expansion compensation.
Casing halves are held together with full hydraulic pressure of the pump assuring a tight seal with a minimum of heavy parts.
Uniform section of both inner and outer casings assures uniform expansion at all points. Expansion stresses are minimized; alignment is held.
Packing also is on outside of pump where it may be adjusted easily and quickly.
A carriage which may be attached to the pump body is furnished with each unit. The inner casing may be removed on this carriage with a minimum of time and effort.

Cost Cutting Features

ALLIS-CHALMERS

NEW BOILER FEED PUMP

HERE IS A PUMP designed to meet the needs of the newer high pressure boiler plants. Efficiency is high, maintenance is low and every design feature has a long record of successful application to boiler feed service.

Sizes range from 1200 to 2500 psig and from 300 to 2000 gpm. Allis-Chalmers can supply the complete boiler feed pump installation including pump, motor and control, of coordinated design and manufacture.

Get the details on this new boiler feed pump from your Allis-Chalmers Sales Office or write Allis-Chalmers, Milwaukee 1, Wisconsin

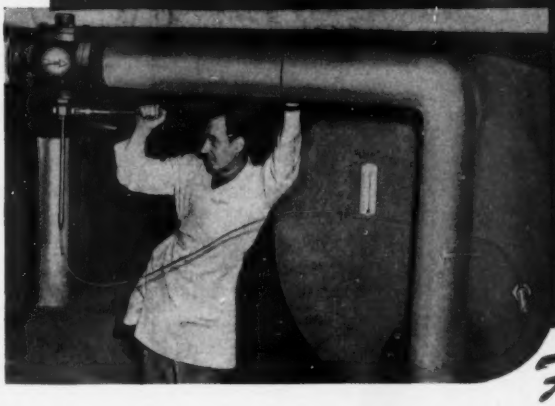
A-3250

A-C ALLIS-CHALMERS

ALLIS-CHALMERS

Hold Everything!

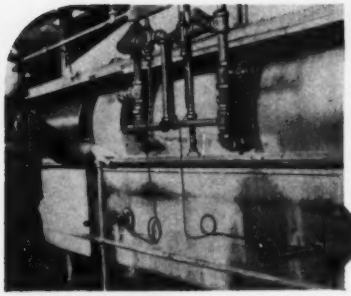
AT CORRECT TEMPERATURES WITH SARCO **TR-21** REGULATORS



HOT WATER

For 20 Years

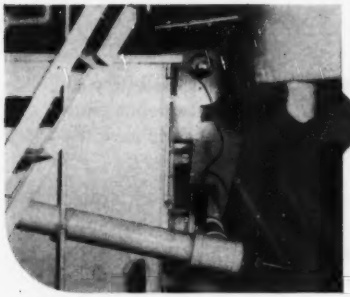
The hot water in this large hotel was held at exactly the right temperature with the Sarco TR-21 regulator illustrated. During all this time there were no complaints because the water was too hot or too cold; and, of course, no heat wasted. Recently a wrench was put on the regulator for the first time and a few dollars worth of new parts installed. Now they look forward to twenty more years of service and saving with Sarco.



PROCESS TANKS

Better Production

No process requires closer regulation than the various tanks in an automatic plating machine. In the plant illustrated, everything is automatic because all temperatures are controlled to within a few degrees by Sarco. The owner reports greatly increased production with practically no rejects and a considerable reduction in the amount of steam used



CAN COOLING

Production Speed-Ups

Here is a can cooling operation which moves warm cans of fruit through a cooler on a conveyor. When operated by hand, water was wasted to be sure the temperature was safe. Even then, cans sometimes came out too warm and food was wasted. Now, with the same TR-21 regulator shown above, less water is used and no food lost. Ask for Sarco Catalog No. 600.

320

SARCO SAVES STEAM

SARCO COMPANY, INC.

Represented in Principal Cities

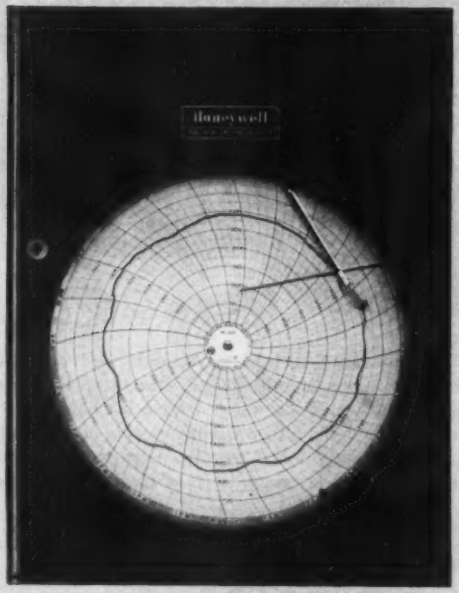
Empire State Building, New York 1, N. Y.

SARCO CANADA, LTD., TORONTO 5, ONTARIO

IMPROVES PRODUCT QUALITY AND OUTPUT

MINNEAPOLIS Honeywell BROWN INSTRUMENTS

...SYMBOL OF SIMPLIFIED OPERATION AND MAINTENANCE



IT WILL PAY YOU TO TAKE A GOOD LOOK *at the* BROWN PRESSURE GAUGE

LIKE all other products that bear the Honeywell nameplate, the Brown Pressure Gauge has established a reputation for sound design and trouble-free performance, with flexibility . . . of practical importance to superintendents, engineers and instrument men.

The Brown Pressure Gauge is available with a variety of measuring elements, each designed for maximum performance in a particular pressure or vacuum range. The availability of the measuring elements in various materials, the ease of range change, the interchangeability of components, *plus* the easy accessibility of parts . . . all add up to a convenience that means simplified operation and maintenance for any application.

This instrument can be supplied with one, two or three pens . . . permitting combinations of pressure, temperature and flow measurement without sacrificing simplicity. And, the desired control form can be obtained from the electronic vane type which permit two or three-position electric control . . . or the pneumatic type control which permits on-off, proportional or proportional with automatic reset.

1 **SPIRAL...** Brown spiral pressure elements consist of a series of Bourdon tubes joined end to end and wound as a flat spiral. The movements of the tubes are additive, resulting in greater movement of the free end. These elements available in bronze, steel or stainless steel . . . are specially heat treated for accuracy and long life . . . possess ample torque and over-range capacity. For pressure ranges from 18 to 4000 psi.

2 **INTERMEDIATE SPRING AND BELLOWS...** This element is comprised of either a brass or stainless steel bellows, enclosed in a shell of corresponding material, and connected to the pressure source which moves it against the opposing force of a spring. A rod on the bottom of the bellows transmits this motion, through linkage, into pen movement. The unit possesses sufficient sensitivity for pressure ranges from 100 inches of water to 40 psi.

3 **ABSOLUTE PRESSURE UNIT...** This element, available in brass or stainless steel, consists of an evacuated bellows containing a calibrated spring and an actuating bellows connected internally with the measured pressure. Supporting castings connect the top of the evacuated bellows and the bottom of the actuating bellows. A movable plate between the two transmits their movement, through linkage, to the recording pen. Ranges from 0 to 60 inches of mercury absolute psi.

4 **LOW-RANGE SPRING AND BELLOWS...** This unit has a relatively large brass bellows, with internal pressure connection. Bellows movement is balanced by an externally mounted spring. For vacuum and compound ranges, a stainless steel spring is mounted in tandem and opposes the collapsing of the bellows caused by the partial vacuum. The element has ample power for pressure ranges from 5 to 90 inches of water.

Take a *good look* at all the features of the Brown Pressure Gauge . . . and then call in your local Honeywell engineer for a discussion of their utilization in your plant. Catalog sent on request.

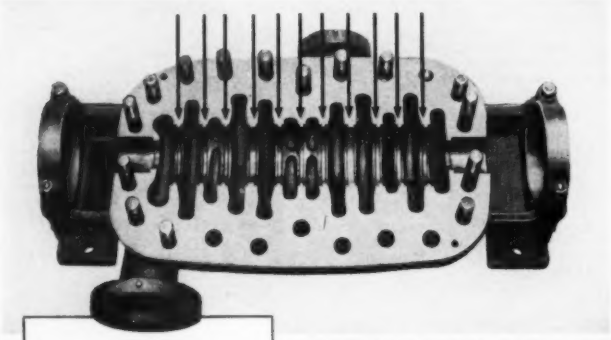
MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, 4490 Wayne Ave., Philadelphia 44, Pa. Offices in more than 80 principal cities of the United States, Canada and throughout the world.

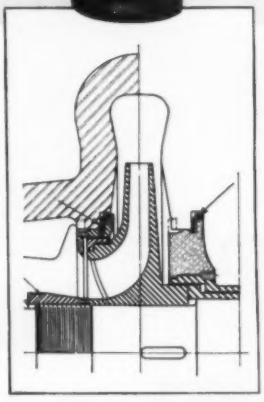
MINNEAPOLIS **Honeywell**

BROWN INSTRUMENTS

IN YOUR BOILER FEED PUMPING...

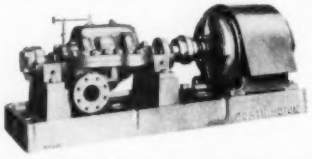
Get **HIGH** *reliability at* **MEDIUM** *pressure with* **LOW** *maintenance cost*





Lower casing half of a Worthington 6-Stage Type UR Centrifugal Volute Pump. Arrows point to joints protected by Worthington Elastic Seal Rings.

← Worthington Elastic Seal Ring construction (solid black areas) in a Type UX Pump. Flexible and resilient, the Elastic Seal Ring assures initial seating, makes joints liquid-tight, eliminates a common cause of pressure loss.



This Worthington Type UQ Pump incorporates the Worthington Elastic Seal Ring, latest improvement in mechanical design.

WORTHINGTON

WORTHINGTON PUMPS, TYPES UQ AND UR, ARE TOP PERFORMERS AT PRESSURES UP TO 950 PSI

In power plants throughout the world Worthington Centrifugal Pumps, Types UQ and UR, have proved themselves the most modern small-capacity boiler feed pumps in the medium pressure range. Correct in every mechanical and hydraulic detail, they feature:

- **Balanced design . . .**
- **No stuffing box trouble . . .**
- **Freedom from interstage leakage . . .**
- **Low Maintenance Cost**

Built for long, trouble-free service, these multi-stage volute-type pumps are by far the most dependable and economical for your boiler feed jobs at pressures up to 950 psi.

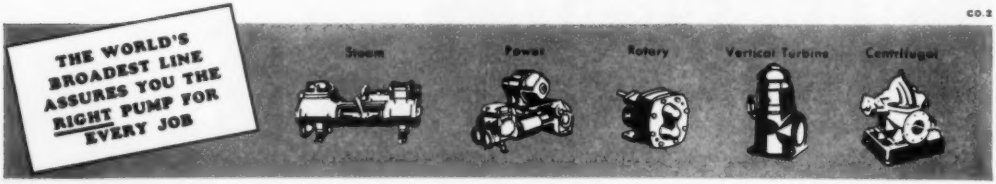
There's A Worthington Pump For Every Pressure Range

from 100 psi to 3000 psi and all outstanding in their class. In this most complete line you're sure to find exactly the right pumps for your own boiler feed requirements, large or small. For further proof that *there's more worth in Worthington*, contact our nearest District Office or write to *Worthington Pump and Machinery Corporation, Centrifugal Pump Division, Harrison, N. J.*

MEMBER

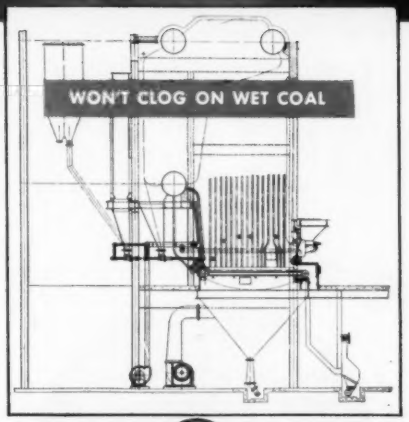
CO.2

THE WORLD'S BROADEST LINE ASSURES YOU THE RIGHT PUMP FOR EVERY JOB



TOP EFFICIENCY FROM LOW AND HIGH ASH COALS

PERFECT SPREAD STOKER



Three AE Perfect Spread 2-feeder, travelling grate Stokers recently installed by a leading pharmaceutical manufacturer in the midwest. The boilers, each with a maximum continuous capacity of 60,000 lbs. per hour are Union "A" Type. Efficiency at normal capacity, 83.4%; at maximum capacity, 82.4%. Consulting Engineer, Austin Company.

In the Boiler Room illustrated, the Perfect Spread Stokers were guaranteed to use coal containing either 13,306 B.T.U. or 11,327 B.T.U. per lb. as fired. These two coals have moisture contents of 4.7% and 10.7%, with ash content of 8.2% and 10.1%, respectively. With either coal, practically the same capacity is available but these Perfect Spread Stokers have done even better than predicted. Five different grades of coal have been used to date . . . and all with top efficiency.

Perfect Spread's unique feeder won't clog on wet coal but feeds uniformly—not in slugs—regardless of moisture content. Its engineered cinder return and adjustable overfire air system give comparable results from either low or high ash coals. Its even feed characteristic insures higher CO_2, freedom from smoke puffs, minimum carbon in the ashpit, and less fly ash. Feeders adjustable from 50 to 7,500 lbs. of coal per hour . . . capacities range from 8,000 to 500,000 lbs. of steam per hour. Mail coupon today for full data.

AMERICAN ENGINEERING COMPANY

PHILADELPHIA 25, PENNA.

AE Products are: Taylor and Perfect Spread Stokers, Marine Deck Auxiliaries, Hele-Shaw and Hydramite Fluid Power, Lo-Hed Hoists, Lo-Hed Car Pullers

American Engineering Company
2400 Aramingo Ave., Philadelphia 25, Pa.

Gentlemen: We are interested in saving fuel dollars. Kindly send booklet giving full information about Perfect Spread Stokers.

Name ..... Title .....

Company .....

Address .....

City ..... Zone ..... State .....

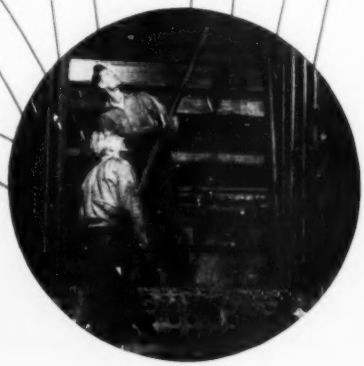
MORE REST FOR BOILER REPAIRMEN

Boilers last longer, with fewer shutdowns for repairs, when Monsanto Santosite (sodium sulfite anhydrous, technical) goes to work preventing oxygen corrosion. And boiler repairmen take it easy!

Safe, economical, easy-to-use Santosite takes *all* the dissolved oxygen out of boiler feed water, simply by combining with the oxygen to form harmless sodium sulfate. Neither Santosite nor sodium sulfate produces sludge or otherwise harms boilers and piping.

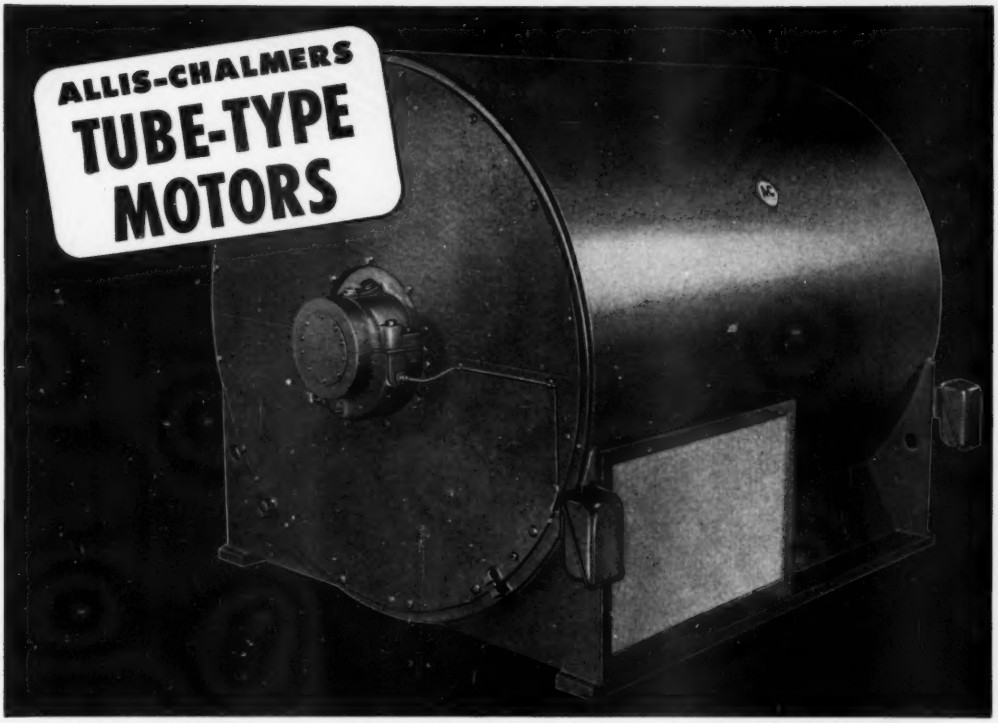
For details on the use of Santosite, supplies of which now are limited, write for a copy of Monsanto Technical Bulletin No. O-26, "*Santosite for Removing Oxygen from Boiler Feed Water*." MONSANTO CHEMICAL COMPANY, Organic Chemicals Division, 1700 South Second Street, St. Louis 4, Missouri.

Santosite: Reg. U. S. Pat. Off.



MONSANTO
CHEMICALS FOR PLASTICS

SERVING INDUSTRY . . . WHICH SERVES MANKIND



Self-Cleaning Motor

Keeps Maintenance Costs Down

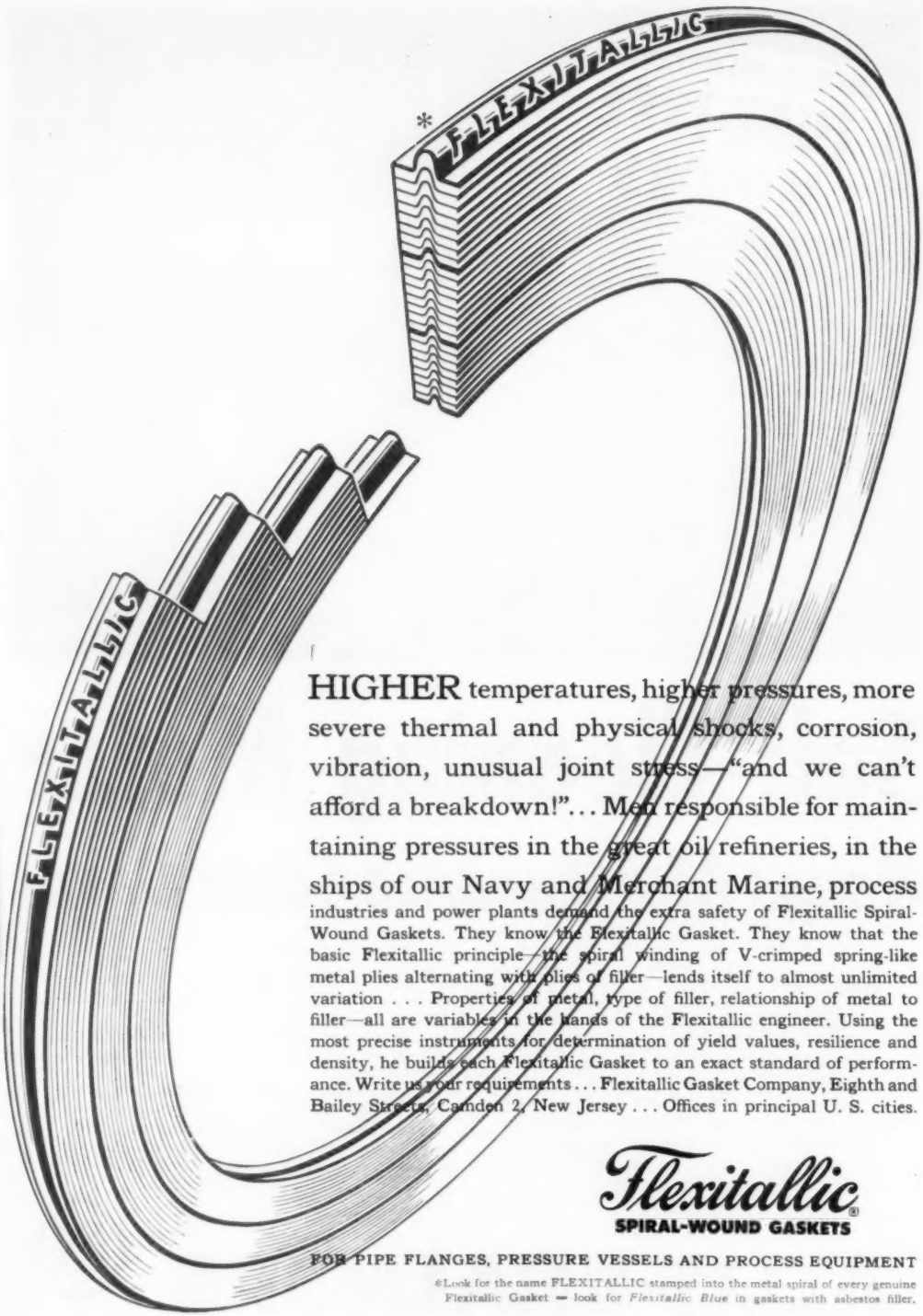
MOTOR CLEANING ROUTINE AND COST ARE PRACTICALLY ELIMINATED by the Allis-Chalmers tube-type, totally-enclosed, fan-cooled motor. Even when installed outdoors in contaminated atmosphere, dirt and corrosion cannot harm it.

The reason for this outstanding performance is the unique tube-type cooling system. Cooling air circulates through a nest of tubes which surrounds the stator, removing heat from the interior of the motor. The generous flow of air through the straight tubes carries dirt out to the atmosphere. There are no corners or pockets, as in conventional designs, which might collect large dirt deposits. If the tubes ever should need cleaning, a brush on a long handle will do the job in a few minutes.

Sizes range from 75 hp up. Tubes and end plates may be made of special corrosion resistant materials where necessary.

To-day, when manpower is high-priced and getting scarce, cutting maintenance time and cost is more important than ever. Ask your Allis-Chalmers representative to show you how this exceptional motor can reduce your maintenance requirements. Or write to Allis-Chalmers, Milwaukee 1, Wisconsin.
Ask for Bulletin 05B7150. A-3322

ALLIS-CHALMERS



HIGHER temperatures, higher pressures, more severe thermal and physical shocks, corrosion, vibration, unusual joint stress—"and we can't afford a breakdown!"... Men responsible for maintaining pressures in the great oil refineries, in the ships of our Navy and Merchant Marine, process industries and power plants demand the extra safety of Flexitallic Spiral-Wound Gaskets. They know the Flexitallic Gasket. They know that the basic Flexitallic principle—the spiral winding of V-crimped spring-like metal plies alternating with plies of filler—lends itself to almost unlimited variation . . . Properties of metal, type of filler, relationship of metal to filler—all are variables in the hands of the Flexitallic engineer. Using the most precise instruments for determination of yield values, resilience and density, he builds each Flexitallic Gasket to an exact standard of performance. Write us your requirements . . . Flexitallic Gasket Company, Eighth and Bailey Streets, Camden 2, New Jersey . . . Offices in principal U. S. cities.

Flexitallic®
SPIRAL-WOUND GASKETS

FOR PIPE FLANGES, PRESSURE VESSELS AND PROCESS EQUIPMENT

*Look for the name FLEXITALLIC stamped into the metal spiral of every genuine Flexitallic Gasket — look for *Flexitallic Blue* in gaskets with asbestos filler.

Power

PHILIP SWAIN, EDITOR • MARCH 1951 • ESTABLISHED 1882

Sabotage Defense Begins With You!

BY AND LARGE, sabotage wasn't much of a problem in World War II. But it looks like a much bigger headache in the times ahead. Here's why we think so.

Last time, we knew we were at war, knew who our enemies were. We could be pretty sure they would depend for sabotage operations on "professional" agents, and traditional counterespionage methods could be used to uncover them. The record shows the FBI and our intelligence people did a good job in flushing out enemy agents and thwarting their plans.

This time, unpalatable though it may be, we must assume we have in our midst native Americans so misguided as to be active communist sympathizers. They will have grown up in our communities, studied in our schools. They'll be members of your bowling club, the PTA, the neighborhood church. If they've been tapped for underground work, you can be sure they'll have no visible connection with the Communist party or leftist causes. In short, they'll be virtually indistinguishable from the rest of us.

We can hope that counterespionage will give us a line on some of them. Careful screening of personnel in our factories and power plants may turn up others. But to be entirely realistic, we must figure that some will go undetected. How then can we guard our vital production facilities against these borers from within?

We'd like to pass along a suggestion from our own experience. Back in the early days of World War II, POWER's editors were consulted on defensive measures against sabotage of power plants. Official thinking then ran along conventional lines—dynamite in the coal pile, etc. We had no trouble showing the relative ineffectiveness of such schemes, but, on first blush, couldn't come up with anything better.

Then somebody remembered the farmer who found the lost mule by imagining where he'd go if he were a mule. In all seriousness, we spent several days "playing" saboteur (with government blessing, of course). We picked several plants we knew from stem to stern. In mind's eye, we examined every part of them from coal pile to busbar, seeking the most vulnerable spots.

We asked ourselves questions like these: "Loss of which equipment would put the plant out of commission most completely and for the longest time? What's the quickest and surest way to damage that piece of equipment? Knowing the plant, how would we go about doing it?"

The resulting sabotage schemes were a far cry from what we started with—and they were surprisingly simple and effective. Best of all, they showed clearly the line defense measures should take.

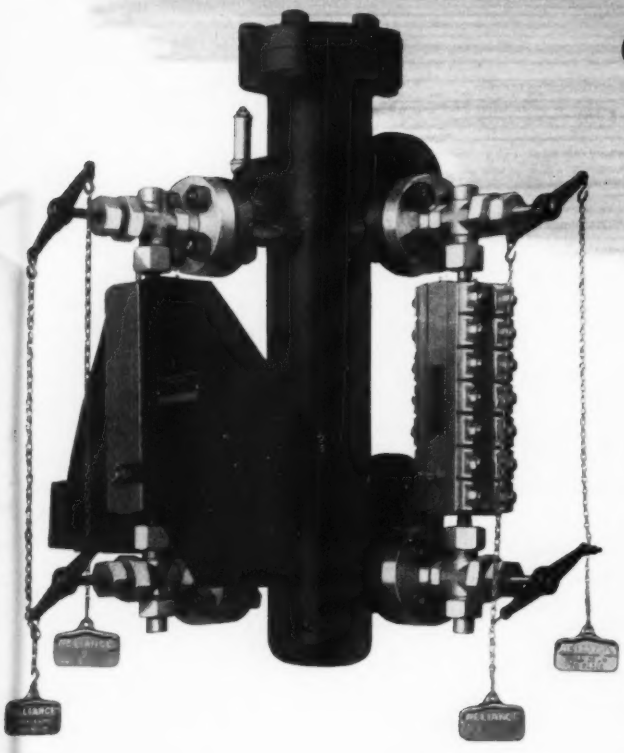
Very briefly, here's what you, as power engineer, might profitably do to protect your plant. First, of course, set up recommended procedures to screen personnel and keep out unauthorized visitors. Then lock yourself in your office for a few hours and mentally put yourself in the place of a saboteur. Where would you strike to cripple your plant? How would you go about doing it?

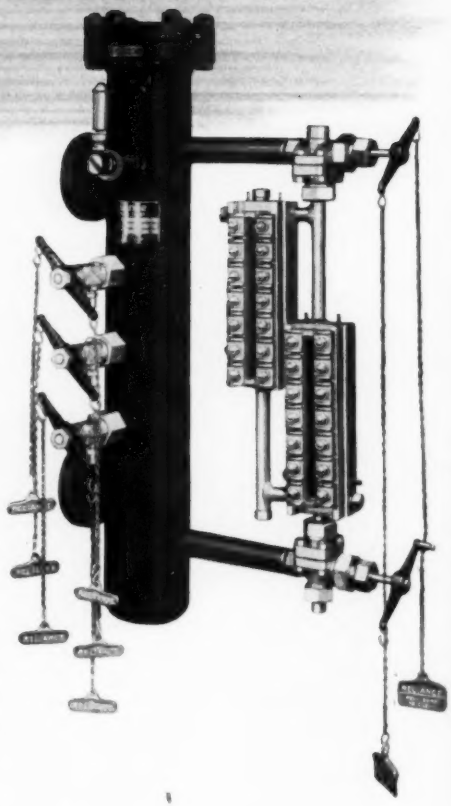
In all this, the most important thing is to let your imagination run free. Don't toss out a scheme merely because it looks screwy at first glance. Many of the best sabotage schemes are effective simply because they're highly unconventional.

For every scheme that finally passes the test of possibility, plan a defense. It's our bet that if you take these "sabotage exercises" seriously and put some creative imagination to work on them, you'll make an investment in plant protection that will pay real dividends because you'll have some idea what you're guarding against.

RELIANCE WATER COLUMNS

for any working steam pressure assure you the *utmost*





Reliance Boiler Safety Devices include Water Gages and other trim for all working steam pressures. Also EYE-HYE, the original all-hydrostatic remote reading water level indicator.

The name that introduced safety water columns..

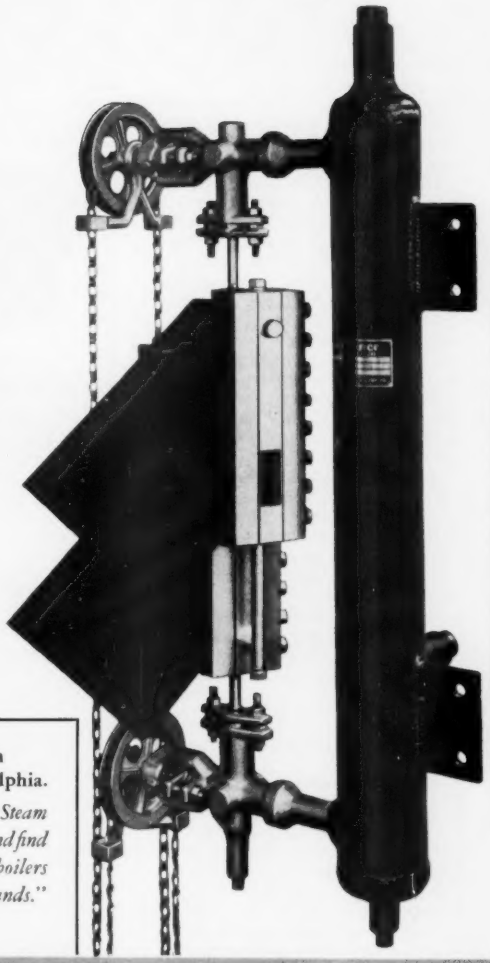
in Dependability

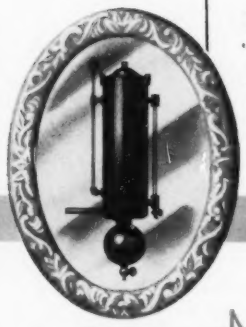
SINCE 1884, Reliance has maintained leadership in Boiler Safety Device development and manufacture. Water Columns with automatic Alarms, operated by the original *instantaneous* alarm mechanism, have helped to fortify power plants against the consequences of boiler water failure for billions of operating hours. Alarms are available on columns for pressures to 900 psi.

For higher pressures, Reliance provides standard and custom-built equipment that embodies principles of design and construction perfected in 67 years of *specializing* in this field—"super-rugged" Water Columns built with a generous extra margin of safety.

Selected as standard equipment by many boiler manufacturers and consulting engineers, Reliance Water Columns exceed the requirements of national and state code authorities. Check with your consultants or ask for our nearest engineer representative.

THE RELIANCE GAUGE COLUMN COMPANY
5902 Carnegie Avenue • Cleveland 3, Ohio





Letter dated May 29, 1896 from
Kalion Chemical Company, Philadelphia.

"Gentlemen: We have equipped our entire Steam Plant with your Safety Water Columns, and find them perfectly satisfactory. One of our boilers has a working pressure of over 175 pounds."

...in 1884 ⇨ **Reliance®**

BOILER SAFETY DEVICES

BYERS WROUGHT IRON

helps to assure a "Sweet-Running Operation" here

A $3,000,000 rehabilitation program has been almost 50% completed at the Imperial Sugar Companies' cane sugar refinery at Sugar Land, Texas. This cane sugar refinery has a daily output of 2,000,000 lbs. of refined sugar. Around-the-clock operation makes equipment dependability a first requirement. In a number of services, this responsibility has been met by the liberal use of genuine wrought iron.

The calandrias (top left) and the vacuum pans in which they are housed, were fabricated from Byers Wrought Iron plates. Steam in the calandria drum boils the concentrated syrup, called massecuite, concentrating it to the crystallizing point. It is then pumped into vertical crystallizers, and held until centrifuging. Two vacuum pans, flanked by two crystallizers, are shown in the construction view of the new seven-story building. A third pan will be installed later.

In addition to this application, where abrasion is the major threat to service life, wrought iron was installed for a number of miscellaneous piping services. The company has used wrought iron pipe for maintenance work for a number of years, so the specification is based on the soundest foundation of all—actual past experience, that demonstrated the ability of wrought iron to do the job right . . . and to keep on doing it.

Why Wrought Iron Lasts

Wrought iron's longer life comes from its unique nature. Tiny fibers of glass-like silicate slag, threaded through the body of high-quality iron, halt and disperse corrosive attack. The fibers also anchor the initial protective scale, which shields the underlying metal.

THE A B C'S OF WROUGHT IRON tells about the material. Ask for a copy.

A. M. Byers Company, Pittsburgh, Pa. Established 1864. Boston, New York, Philadelphia, Washington, Atlanta, Chicago, St. Louis, Houston, Salt Lake City, San Francisco. Export Division: New York, N. Y.

BYERS

CORROSION COSTS YOU MORE THAN WROUGHT IRON

WROUGHT IRON

TUBULAR AND HOT ROLLED PRODUCTS

ELECTRIC FURNACE QUALITY ALLOY AND STAINLESS STEEL PRODUCTS

Power Handbook

BASIC POWER FACTS MADE EASY

PART ONE

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By **PHILIP SWAIN**, Editor and **WILLIAM ARROTT**, Assistant Editor

Continued demand for copies of the original *Power* Handbook, long after reprint stocks were exhausted, has impelled *Power* to publish this new edition — completely rewritten and expanded to include fresh data, suggestions from the many readers who use the first edition, and the latest techniques in easy-to-read engineering journalism.

Here are the rock-bottom data of power engineering -- the basic scientific facts behind thousands of practical applications — presented in the form that practical men understand. These tables, formulas, charts and concise statements are the foundation of a professional approach to the solution of everyday engineering problems.

Part two, completing this handbook of fundamental facts, will appear in a later issue.

WEIGHTS & MEASURES Useful Conversions

UNITS OF POWER

1 kw = 1.3415 hp = 738 ftlb*/sec = 44,268 ftlb/min = 2,656,100 ftlb/hr = .948 Btu/sec = 56.9 Btu/min = 3413 Btu/hr
1 hp = .7455 kw = 550 ftlb/sec = 33,000 ftlb/min = 1,980,000 ftlb/hr = .707 Btu/sec = 42.4 Btu/min = 2544 Btu/hr
1 ftlb/sec = .001355 kw = .001818 hp = 60 ftlb/min = 3600 ftlb/hr = .001284 Btu/sec = .0771 Btu/min = 4.62 Btu/hr
1 ftlb/min = .00002259 kw = .0000303 hp = .01667 ftlb/sec = 60 ftlb/hr = .00002141 Btu/sec = .001284 Btu/min = .0771 Btu/hr
1 ftlb/hr = .000000376 kw = .000000505 hp = .000278 ftlb/sec = .01667 ftlb/min = .000000357 Btu/sec = .00002141 Btu/min = .001284 Btu/hr
1 Btu/sec = 1.055 kw = 1.416 hp = 778 ftlb/sec = 46,700 ftlb/min = 2,802,000 ftlb/hr = 60 Btu/min = 3600 Btu/hr
1 Btu/min = .01759 kw = .02359 hp = 12.98 ftlb/sec = 778 ftlb/min = 46,700 ftlb/hr = .01667 Btu/sec = 60 Btu/hr
1 Btu/hr = .0002931 kw = .0003932 hp = .2163 ftlb/sec = 12.98 ftlb/min = 778 ftlb/hr = .0002778 Btu/sec = .01667 Btu/min

** Ftlb, above, and in. lb, table below, mean foot pound and inch pound, the work done in moving against one lb resistance a distance on one ft and one in., respectively.*

UNITS OF WORK, ENERGY, HEAT

1 Btu = 9340 in. lb = 778.3 ftlb = .0002930 kwhr** = .0003931 hphr
1 in. lb = .0001070 Btu = .0833 ftlb = .00000003137 kwhr = .0000000421 hphr
1 ftlb = .001284 Btu = 12 in. lb = .000000376 kwhr = .000000505 hphr
1 kwhr = 3413 Btu = 31,873,000 in. lb = 2,656,100 ftlb = 1.342 hphr
1 hphr = 2544 Btu = 23,760,000 in. lb = 1,980,000 ftlb = 0.7455 kwhr

*** 1 kilowatthour = 3413 Btu and 1 Btu = 778.3 ftlb.*

UNITS OF VOLUME

1 cu in. = .00433 gal = .000579 cu ft = .0000214 cu yd
1 gal = 231 cu in. = .1337 cu ft = .00495 cu yd = .00000307 acre ft*
1 cu ft = 1728 cu in. = 7.48 gal = .0370 cu yd = .0000230 acre ft
1 cu yd = 46,656 cu in. = 202.0 gal = 27 cu ft = .000620 acre ft
1 acre ft = 325,800 gal = 43,560 cu ft = 1613 cu yd

** Acre ft of water is the volume in 1 ft of depth covering 1 acre.*

UNITS OF TIME

1 sec = .01667 min = .0002778 hr = .00001157 days = .0000003805 mo* = .0000000317 yr
1 min = 60 sec = .01667 hr = .000694 days = .0000228 mo = .000001903 yr
1 hr = 3600 sec = 60 min = .0417 days = .001370 mo = .0001142 yr
1 day = 86,400 sec = 1440 min = 24 hr = .0329 mo = .002740 yr
1 mo = 2,628,000 sec = 43,800 min = 730 hr = 30.4 days = .0833 yr
1 yr = 31,536,000 sec = 525,600 min = 8760 hr = 365 days = 12 mo

** Month used is exactly 1/12 year.*

Power originally published these conversion tables as data sheets some years back. They were drawn up purposely in the units power engineers use most frequently. Figures given here are generally carried to only three or four significant figures*, which is more than accurate enough for most power-plant computations. Following are several ways to use tables:

EXAMPLE 1. How much heat per hour is generated by a brake applied to drag 40 lb on the rim of a pulley moving 2000 fpm?

Solution. Work done in foot pounds per minute is 40 x 2000 = 80,000. *Units of Power* shows that 1 ftlb per min equals 0.0771 Btu per hr. Therefore hourly heat generated is 80,000 x 0.077 = 6160 Btu. *(Note that 0.0771 was rounded off to 0.077 for calculation. That's because brake drag and pulley speed were only given to one significant figure. Pulley speed could actually be 2010 fpm and most engineers would still call it 2000.)*

EXAMPLE 2. A 19-oz weight on a 0.6-sq-ft soft diaphragm balances air pressure on the other side of the diaphragm. What is the air pressure in inches of water?

Solution. Pressure is 19 ÷ 0.6 = 31.7 oz per sq ft. *Units of Pressure* shows that 1 oz per sq ft equals 0.012 in. of water. So pressure equals 31.7 x 0.012 = 0.38 in. water.

EXAMPLE 3. What kilowatt power is required (neglecting losses) to hoist 1500 lb at the rate of 20 fps?

Solution. Foot-pounds work per second are 20 x 1500 = 30,000. From *Units of Power* 1 ftlb per sec equals 0.001355 kw. Therefore theoretical power equals 30,000 x 0.001355 = 40.7 kw (Actually 40.65 but 40.7 is close enough.)

EXAMPLE 4. A leaky faucet tests 1 gal waste in 5 min. What is yearly waste?

Solution. Gallons per min is 0.2. *Units of Time shows* 525,600 min per year. Yearly water loss is 525,000 x 0.20 = 105,000 gal.

EXAMPLE 5. A rectangular tub measuring 66 x 48 x 36 in. is brim full of water. How long will it take to drain at the rate of 5 gallons per minute?

Solution. Volume of water in cu in. = 66 x 48 x 36 = 114,000 cu in. *Units of Volume* shows 0.00433 gal per cu in. Volume in gallons equals 114,000 x 0.00433 = 494 gal. At 5 gpm, time needed to drain tank equals 494 ÷ 5 = 99 min — or a little over an hour and a half.

*Significant figures are the number of digits in a number regardless of decimal point. Both 123,000 and 0.00123 have three significant figures.

to Help Solve Common Power-Plant Problems

UNITS OF VELOCITY

1 fps = 60 fpm = 3600 fph = .01136 mpm = .682 mph

1 fpm = .01667 fps = 60 fph = .0001894 mpm = .01136 mph

1 fph = .0002778 fps = .01667 fpm = .00000316 mpm = .0001894 mph

1 mpm = 88 fps = 5280 fpm = 316,800 fph = 60 mph

1 mph = 1.467 fps = 88 fpm = 5280 fph = .01667 mpm

f = feet; h = hours; m = miles or minutes; p = per; s = seconds

UNITS OF PRESSURE

1 in. water* = .0833 ft water = .0735 in. Hg = .577 oz/sq in. = 83.1 oz/sq ft = .0361 lb/sq in. = 5.20 lb/sq ft

1 ft water = 12 in. water = .882 in. Hg = 6.93 oz/sq in. = 998 oz/sq ft = .433 lb/sq in. = 62.4 lb/sq ft

1 in. Hg = 13.61 in. water = 1.134 ft water = 7.86 oz/sq in. = 1131 oz/sq ft = .491 lb/sq in. = 70.7 lb/sq ft

1 oz/sq in. = 1.732 in. water = .1443 ft water = .1276 in. Hg = 144 oz/sq ft = .0625 lb/sq in. = 9 lb/sq ft

1 oz/sq ft = .01203 in. water = .001002 ft water = .000884 in. Hg = .00694 oz/sq in. = .000434 lb/sq in. = .0625 lb/sq ft

1 lb/sq in. = 27.71 in. water = 2.31 ft water = 2.04 in. Hg = 16 oz/sq in. = 2304 oz/sq ft = 144 lb/sq ft

1 lb/sq ft = .1924 in. water = .01604 ft water = .01414 in. Hg = .1111 oz/sq in. = 16 oz/sq ft = .00694 lb/sq in.

** In. water means inches head of water at 60 F. In. Hg is inches head mercury at 32 F.*

Don't use any more significant figures than you measure. If you measure to nearest foot, don't figure to nearest inch

UNITS OF LENGTH

1 in. = .0833 ft = .0277 yd = .0000158 miles
1 ft = 12 in. = .333 yd = .000189 miles
1 yd = 36 in. = 3 ft = .000568 miles
1 mile = 63,360 in. = 5280 ft = 1760 yd

UNITS OF WEIGHT

1 gr = .00229 oz* = .0001429 lb = .0000000714 tons
1 oz = 437.5 gr = .0625 lb = .00003215 tons
1 lb = 7000 gr = 16 oz = .000500 tons
1 ton = 14,000,000 gr = 32,000 oz = 2000 lb

** Avoirdupois oz and lb, short ton of 2000 lb*

WEIGHT-TIME RATES

1 lb/sec = 60 lb/min = 3600 lb/hr = 86,400 lb/day = 2,628,000 lb/mo* = 31,536,000 lb/yr
1 lb/min = .01667 lb/sec = 60 lb/hr = 1440 lb/day = 43,800 lb/mo = 525,600 lb/yr
1 lb/hr = .0002778 lb/sec = .01667 lb/min = 24 lb/day = 730 lb/mo = 8760 lb/yr
1 lb/day = .00001157 lb/sec = .000694 lb/min = .0417 lb/hr = 30.4 lb/mo = 365 lb/yr
1 lb/mo = .000000381 lb/sec = .0000228 lb/min = .001370 lb/hr = .0329 lb/day = 12 lb/yr
1 lb/yr = .0000000317 lb/sec = .000001903 lb/min = .0001142 lb/hr = .002740 lb/day = .0833 lb/mo

** Month used is exactly 1/12 year = 30.4 days.*

UNITS OF AREA

1 cir mil* = 0.000000785 sq in.
1 sq in. = 1,273,200 cir mils = .00694 sq ft = .000772 sq yd
1 sq ft = 144 sq in. = .1111 sq yd = .00002296 acres
1 sq yd = 1296 sq in. = 9 sq ft = .0002066 acres
1 acre = 43,560 sq ft = 4840 sq yd

** A cir (circular) mil is the area of a circle of 1/1000 in. dia. Thus, a round rod of 1-in. dia. has an area of 1,000,000 cir mils.*

UNITS OF DENSITY

1 lb/cu in. = 1728 lb/cu ft = 0.864 tons*/cu ft = 23.3 tons/ cu yd = 231 lb/gal
1 lb/cu ft = .000579 lb/cu in. = .000500 tons/cu ft = .0135 tons/cu yd = .1337 lb/gal
1 ton/cu ft = 1.157 lb/cu in. = 2000 lb/cu ft = 27 tons/cu yd = 267 lb/gal
1 ton/cu yd = .0429 lb/cu. in. = 74.1 lb/cu ft = .0370 tons/cu ft = 9.90 lb/gal
1 lb/gal = .00433 lb/cu in. = 7.48 lb/cu ft = .00374 tons/cu ft = .1010 tons/cu yd

** Tons are short = 2000 lb.*

VOLUME-FLOW RATES

1 cu ft/sec = 60 cu ft/min = 3600 cu ft/hr = 7.48 gal/sec = 448.8 gal/min = 26,930 gal/hr
1 cu ft/min = .01667 cu ft/sec = 60 cu ft/hr = .1247 gal/sec = 7.48 gal/min = 448.8 gal/hr
1 cu ft/hr = .0002778 cu ft/sec = .01667 cu ft/min = .002078 gal/sec = .1247 gal/min = 7.48 gal/hr
1 gal/sec = .1337 cu ft/sec = 8.02 cu ft/min = 481 cu ft/hr = 60 gal/min = 3600 gal/hr
1 gal/min = .002228 cu ft/sec = .1337 cu ft/min = 8.02 cu ft/hr = .01667 gal/sec = 60 gal/hr
1 gal/hr = .0000371 cu ft/sec = .002228 cu ft/min = .1337 cu ft/hr = .0002778 gal/sec = .01667 gal/min

HANDLING FORMULAS

Most rules for engineering calculations are set down in formulas, which are nothing more than a mathematical shorthand, usually taking the form of equations. Here are some things you can do with equations. Remember that each letter in an equation stands for a quantity of something.

ADDITION, SUBTRACTION. If equals are added to equals, the results are equal: If $a = b$ and $c = d$, then

$a + c = b + d$ or $a - c = b - d$

Quantities may be changed from one side of an equation by changing "sign":

If $a + b = c$, then $a = c - b$.

MULTIPLICATION, DIVISION. If equals are multiplied by equals, results are equal: If $a = b$ and $c = d$ then

$a \times c = b \times d$ or $a \div c = b \div d$

Quantities may be changed from one side to the other by multiplying or dividing both sides by the quantity: If $a \div b = c$, then $b \times a \div b = c \times b$, or $a = b \times c$.

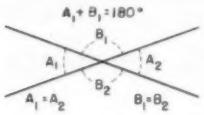
PARENTHESES. A quantity outside a parenthesis multiplies all quantities inside: $a(b + c - d) = ab + ac - ad$ (Note: $a \times b = ab$; $a \div b = a/b$.)

POWERS, ROOTS. Both sides of an equation may be raised to any power. If $a = b$, then $a^2 = b^2$ or $\sqrt{a} = \sqrt{b}$.

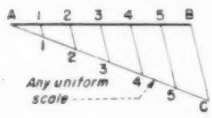
And if $a^2 = b$, then $a = \sqrt{b}$.

UNITS. Watch out for proper units or dimensions in equations. If $W = t \times d$ and t is *lb* and d is *ft*, then W is *ftlb*. But constants have dimensions, too. If $W = 12 \times t \times d$, then W is *in. lb*, because *12* stands for *12 in. per ft*. Most formulas are written for specific units.

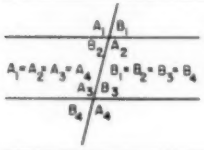
USEFUL GEOMETRIC FACTS



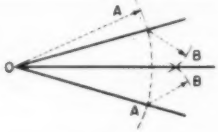
VERTICAL ANGLES. When straight lines cross, opposite or "vertical" angles are equal. Adjacent angles add up to 180 deg



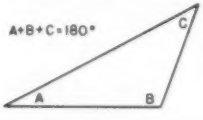
DIVIDING LINE TO SCALE. To divide line *AB*, draw known scale *AC* at convenient angle. Connect B to C. Draw parallel lines



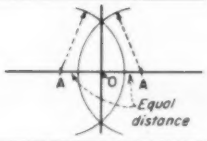
PARALLEL LINES. When straight line crosses parallel lines, indicated angles are equal



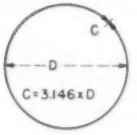
BISECTING ANGLE. Swing equal arcs from points *A*. Draw line from O through intersection



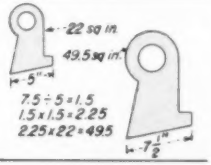
INTERIOR ANGLES. The sum of the interior angles of any triangle always equals 180 deg



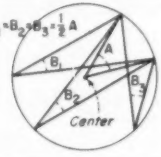
ERECTING PERPENDICULAR. From points *A* swing two equal arcs. Draw line through intersections



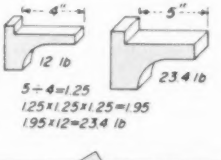
CIRCUMFERENCE OF A CIRCLE. Circumference equals 3.1416 × diameter, 6.2832 × radius



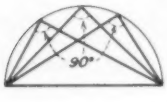
ENLARGING AREAS. As size increases, the area goes up as the square of any dimension



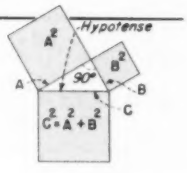
SUBTENDED ANGLES. Angle subtended by arc at center of a circle is twice angle at edge



ENLARGING VOLUMES. Both volume and weight (if same material) vary as dimension cubed



ANGLES IN SEMICIRCLES. Any angle drawn in a semicircle will always be 90 degrees



RIGHT TRIANGLES. The square of the hypotenuse equals the sum of the squares of the two legs

READING A SLIDE RULE

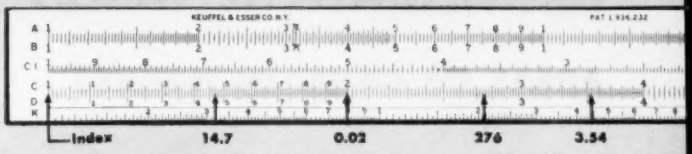
About the only mathematical computation a slide rule *won't* do is add and subtract. Most common uses are for multiplication, division, proportion, squares and roots as shown at right. These operations use only the *A, B, C* and *D* scales. The *K* scale is for cubes and cube roots. The cube root of a number on the *K* scale appears directly above it on the *D* scale. The *CI* or inverted scale is for dividing by multiplication. Here's how: Set right-hand index of slide at 9 on *D* scale. Move hairline to 2 on *CI* scale; read off 4.5 from *D* scale.

PLACING DECIMAL POINT. The slide rule won't tell you where to put decimal points. The division marked 6 could be 6 or 60 or 600 or 0.6, etc. Best method is to forget decimal points until calculation is finished, then estimate with round numbers.

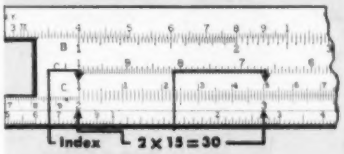
ACCURACY. A normal 10-in. slide rule can be read only to three digits (four digits near left-hand index). This will give an error of about 0.2 percent.

For other slide-rule uses, consult instruction books.

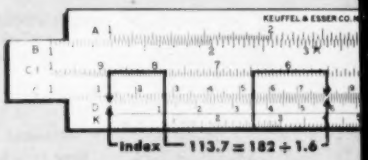
THE FOUR BASIC STEPS



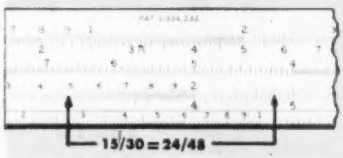
NUMBERS on rule do not include decimal point — only significant figures. Any point marked 1 can be an *index*. Hairline slide (not shown) helps locate numbers



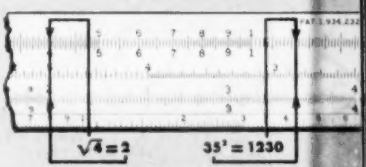
MULTIPLY by setting C-scale *index* on one number on *D* scale. Answer on *D* scale opposite other number on C



DIVIDE by setting C-scale number on *D*-scale number it's divided by. Answer is on C scale opposite *D*-scale *index*



PROPORTIONS are set like fractions with numerators set up on the C scale above their denominators on *D* scale



SQUARE ROOTS of *A*-scale numbers are on *D* scale. Left-hand *A*-scale numbers have odd number of digits

TRIGONOMETRY

The sides and angles of a right triangle bear definite relationships to each other. These are called sines, cosines and tangents of the angles, see sketch.

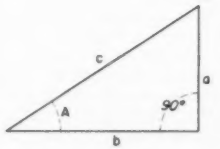
By using these functions, it's possible to figure the leng'h of all sides and size of both angles in a right triangle when only one angle and one side is known.

Values of sin, cos and tan for angles from 0 to 90 degrees are listed in table on page 80. Following are examples of ways to use them. Best way to solve problems is to draw a simple sketch and label all known dimensions.

EXAMPLE 1. A pipe is pitched downward 5 degrees from horizontal. How far does it fall per 10 ft of length?

Solution. Use formula $a = c \times sin\ A$. From table page 80, sin 5 deg is 0.0872. Pipe falls $10 \times 0.0872 = 0.872$ ft.

EXAMPLE 2. A 6-ft ladder leaning against a wall is 3 ft out at the bottom.



Sin	A	=	a	÷	c	a	=	c	×	Sin	A	c	=	a	÷	Sin	A
Cos	A	=	b	÷	c	b	=	c	×	Cos	A	c	=	b	÷	Cos	A
Tan	A	=	a	÷	b	a	=	b	×	Tan	A	b	=	a	÷	Tan	A

What is angle it makes with floor?

Solution. Use formula $\cos A = b \div c$. Cos A = 3 ÷ 6 = 0.5. In table page 80, angle whose cosine is 0.5 is 60 deg.

EXAMPLE 3. The front wall of a room 20 ft. long is 2 ft. higher than the back wall. What angle does the ceiling make with the front wall?

Solution. Use formula *tan* $A = a \div b$. Tan A = 20 ÷ 2 = 10. Nearest angle in table page 80 is 84 degrees.

THINGS TO WATCH. Table on page 80 lists values only for even degrees. For tables listing angles in tenths or minutes, see standard handbooks. Avoid any tables marked *logarithms* of functions and use only those marked trigonometric or *natural* functions.

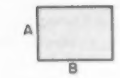
In some formulas the functions co-*tangent* (cot), *secant* (sec) and cose-*cant* (cosec) are used. These are merely reciprocals of tangent, cosine, sine.

$$\tan = \frac{1}{\cot} \quad \cos = \frac{1}{\sec} \quad \sin = \frac{1}{\text{cosec}}$$

Angles over 90 deg. can be converted to angles between 0 and 90 for solving problems. Subtract angles between 90 and 180 from 180. Subtract 180 from angles between 180 and 270. Subtract angles over 270 from 360. Thus 60, 120, 240, 300 deg have same sin, cos, tan.

MATHEMATICAL TABLES

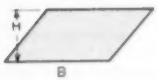
AREAS OF COMMON FIGURES



RECTANGLE
Area = AB

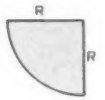
HEXAGON
Area = 0.866D²

SEGMENT
Sector — Triangle

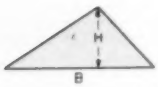


PARALLELOGRAM
Area = BH

OCTAGON
Area = 0.828D²



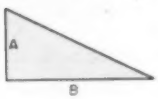
¼ ROUND
Area = 0.785R²



TRIANGLE
Area = ½BH

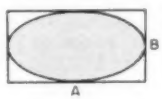
CIRCLE
Area = 0.785D²

90° FILLET
Area = 0.215R²

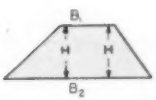


RIGHT TRIANGLE
Area = ½AB

RING
0.785 (D² − d²)



ELLIPSE
Area = 0.785AB



TRAPEZOID
½H (B₁ + B₂)

SECTOR
R²A ÷ 115

PARABOLIC SECTION
Area = ⅔XY

HINTS ON USING TABLES

INTERPOLATING. (Finding values between those listed in a table). Find sine 48.3 deg. Table, page 80, lists: Sin 48 = 0.7431; sin 49 = 0.7547.

Subtracting: 0.7547 − 0.7431 = 0.0116

Then 0.3 × 0.0116 = 0.0035

So sin 48.3 = 0.7431 + 0.0035 = 0.7466

This method of interpolation is accurate enough for most tables used in normal engineering work *providing* gap between the two quantities is small. If gap is too great, interpolation may be inaccurate.

ACCURACY. Find the square root of 74.5 by interpolation from table, page 81. Square root of 74 is 8.602; square root of 75 is 8.660; difference is 0.058. 0.5 × 0.058 = 0.029; 0.029 + 8.602 = 8.631 Actual square root is 8.643; so error is only 0.14 per cent.

(To figure per cent error: Take difference between interpolated and actual values; divide by actual value and multiply by 100.)

However, interpolating the square root of 2.5 from the square roots of 2 and 3 is much more inaccurate because the per cent gap between 2 and 3 is very large. Interpolated square root would be 1.573; actual square root is 1.581. Error is about 0.5 per cent.

Take Table 2, page 90. Interpolate between 30 and 40 psia to find saturation temperature for 35 psia. Interpolated temperature is 258.79 F. Actual value is 259.28 F. Error is 0.2 per cent.

EXTENDING TABLES. To bring numbers below 1 or above 100 into the square-root table, move the decimal point an even number of places to right or left until number falls between 1 and 100. Read square root, then move decimal back half the number of places. For squares, move decimal point back twice the number of places moved originally.

To find square and root of 0.5, move two places to right to get 50. Square root of 50 is 7.071. Move decimal back one place, read 0.7071, the square root of 0.5. Square of 50 is 2500. Move decimal back four places, read 0.25, which is 0.5 squared.

FRACTIONS TO DECIMALS

1/2	0.5	1/11	0.09091
1/3	0.3333	1/12	0.08333
1/4	0.25	1/13	0.07692
1/5	0.2	1/14	0.07143
1/6	0.1667	1/15	0.06667
1/7	0.1428	1/16	0.0625
1/8	0.125	1/17	0.05882
1/9	0.1111	1/18	0.05556
1/10	0.1	1/19	0.05263

INCHES TO FOOT DECIMALS

Inches	Feet	Inches	Feet
1	.0833	7	.5833
2	.1667	8	.6667
3	.2500	9	.7500
4	.3333	10	.8333
5	.4167	11	.9167
6	.5000	12	1.0000

COMPLEX AREAS

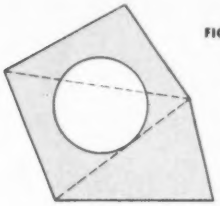
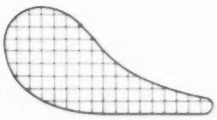


FIGURE METHOD

Divide the complex figure into simple figures and add up the area of each. Here, add up areas of the three triangles and subtract area of the circle



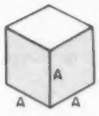
SQUARE METHOD

Transfer shape to squared paper or place transparent squared paper over shape. Count the squares within figure, add estimated fractional squares

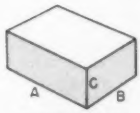
STRIP METHOD

Divide shape into parallel strips of equal width. Area (approximate) is sum of the lengths of all strips times width of one strip

COMMON VOLUMES



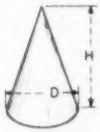
CUBE
Volume = A^3



RECTANGULAR SOLID
Volume = ABC

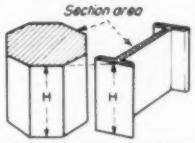
SPHERE
Volume = $0.524D^3$

CYLINDER
$0.785D^2H$

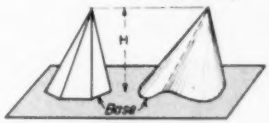


CONE
$0.262D^2H$

FRUSTRUM
$0.262H\ (D_1^2 + D_1D_2 + D_1^2)$



ANY PRISM OR CYLINDER
Volume equals height times cross-sectional area



ANY CONE OR PYRAMID
Volume equals ⅓ height times area of the base

INCH FRACTIONS TO INCH AND FOOT DECIMALS

Inches, Fractions	Inches, Decimals	Feet, Decimals	Inches, Fractions	Inches, Decimals	Feet, Decimals	Inches, Fractions	Inches, Decimals	Feet, Decimals
1/64	.0156	.0013	11/32	.3438	.0287	43/64	.6719	.0560
1/32	.0313	.0026	23/64	.3594	.0299	11/16	.6875	.0573
3/64	.0469	.0039				45/64	.7031	.0586
1/16	.0625	.0052	3/8	.3750	.0313	23/32	.7188	.0599
5/64	.0781	.0065	25/64	.3906	.0326	47/64	.7344	.0612
3/32	.0938	.0078	13/32	.4063	.0339			
7/64	.1094	.0091	27/64	.4219	.0352	3/4	.7500	.0625
			7/16	.4375	.0365	49/64	.7656	.0638
1/8	.1250	.0104	29/64	.4531	.0378	25/32	.7813	.0651
9/64	.1406	.0117	15/32	.4688	.0391	51/64	.7969	.0664
5/32	.1563	.0130	31/64	.4844	.0404	13/16	.8125	.0677
11/64	.1719	.0143				53/64	.8281	.0690
3/16	.1875	.0156	1/2	.5000	.0417	27/32	.8437	.0703
13/64	.2031	.0169	33/64	.5156	.0430	55/64	.8594	.0716
7/32	.2188	.0182	17/32	.5313	.0443			
15/64	.2343	.0195	35/64	.5469	.0456	7/8	.8750	.0729
			9/16	.5625	.0469	57/64	.8906	.0742
1/4	.2500	.0208	37/64	.5781	.0482	29/32	.9063	.0755
17/64	.2656	.0221	19/32	.5938	.0495	59/64	.9219	.0768
9/32	.2813	.0234	39/64	.6094	.0508	15/16	.9375	.0781
19/64	.2969	.0247	5/8	.6250	.0521	61/64	.9531	.0794
5/16	.3125	.0260	41/64	.6406	.0534	31/32	.9688	.0807
21/64	.3281	.0273	21/32	.6563	.0547	63/64	.9844	.0820

CIRCUMFERENCES AND AREAS OF CIRCLES

Diameters 1 to 10 by tenths

Dia	1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9
Circum	3.142	3.456	3.770	4.084	4.398	4.712	5.027	5.341	5.655	5.969
Area	0.785	0.950	1.131	1.327	1.539	1.767	2.011	2.270	2.545	2.835
Dia	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9
Circum	6.283	6.597	6.912	7.226	7.540	7.854	8.168	8.482	8.796	9.111
Area	3.142	3.464	3.801	4.155	4.524	4.909	5.309	5.726	6.158	6.605
Dia	3.0	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.8	3.9
Circum	9.425	9.739	10.05	10.37	10.68	11.00	11.31	11.62	11.94	12.25
Area	7.069	7.548	8.042	8.533	9.079	9.621	10.18	10.75	11.34	11.95
Dia	4.0	4.1	4.2	4.3	4.4	4.5	4.6	4.7	4.8	4.9
Circum	12.57	12.88	13.19	13.51	13.82	14.14	14.45	14.77	15.08	15.39
Area	12.57	13.20	13.85	14.52	15.21	15.90	16.62	17.35	18.10	18.86
Dia	5.0	5.1	5.2	5.3	5.4	5.5	5.6	5.7	5.8	5.9
Circum	15.71	16.02	16.34	16.65	16.96	17.28	17.59	17.91	18.22	18.54
Area	19.63	20.43	21.24	22.06	22.90	23.76	24.63	25.52	26.42	27.34
Dia	6.0	6.1	6.2	6.3	6.4	6.5	6.6	6.7	6.8	6.9
Circum	18.85	19.16	19.48	19.79	20.11	20.42	20.73	21.05	21.36	21.68
Area	28.27	29.22	30.19	31.17	32.17	33.18	34.21	35.26	36.32	37.39
Dia	7.0	7.1	7.2	7.3	7.4	7.5	7.6	7.7	7.8	7.9
Circum	21.99	22.31	22.62	22.93	23.25	23.56	23.88	24.19	24.50	24.82
Area	38.48	39.59	40.72	41.85	43.01	44.18	45.36	46.57	47.78	49.02
Dia	8.0	8.1	8.2	8.3	8.4	8.5	8.6	8.7	8.8	8.9
Circum	25.13	25.45	25.76	26.08	26.39	26.70	27.02	27.33	27.65	27.96
Area	50.27	51.53	52.81	54.11	55.42	56.75	58.09	59.45	60.82	62.21
Dia	9.0	9.1	9.2	9.3	9.4	9.5	9.6	9.7	9.8	9.9
Circum	28.27	28.59	28.90	29.22	29.53	29.85	30.16	30.47	30.79	31.10
Area	63.62	65.04	66.48	67.93	69.40	70.88	72.38	73.90	75.43	76.98

Diameters 10 to 100

Dia	10	11	12	13	14	15	16	17	18	19
Circum	31.42	34.56	37.70	40.84	43.98	47.12	50.27	53.41	56.55	59.69
Area	78.54	95.03	113.1	132.7	153.9	176.7	201.1	227.0	254.5	283.5
Dia	20	21	22	23	24	25	26	27	28	29
Circum	62.83	65.97	69.12	72.26	75.40	78.54	81.68	84.82	87.96	91.11
Area	314.2	346.4	380.1	415.5	452.4	490.9	530.9	572.6	615.8	660.5
Dia	30	31	32	33	34	35	36	37	38	39
Circum	94.25	97.39	100.5	103.7	106.8	110.0	113.1	116.2	119.4	122.5
Area	706.9	754.8	804.2	855.3	907.9	962.1	1018.	1075.	1134.	1195.
Dia	40	41	42	43	44	45	46	47	48	49
Circum	125.7	128.8	131.9	135.1	138.2	141.4	144.5	147.7	150.8	153.9
Area	1257.	1320.	1385.	1452.	1521.	1590.	1662.	1735.	1810.	1886.
Dia	50	51	52	53	54	55	56	57	58	59
Circum	157.1	160.2	163.4	166.5	169.6	172.8	175.9	179.1	182.2	185.4
Area	1963.	2043.	2124.	2206.	2290.	2376.	2463.	2552.	2642.	2734.
Dia	60	61	62	63	64	65	66	67	68	69
Circum	188.5	191.6	194.8	197.9	201.1	204.2	207.3	210.3	213.6	216.8
Area	2827.	2922.	3019.	3117.	3217.	3318.	3421.	3526.	3632.	3739.
Dia	70	71	72	73	74	75	76	77	78	79
Circum	219.9	223.1	226.2	229.3	232.5	235.6	238.8	241.9	245.0	248.2
Area	3848.	3959.	4072.	4185.	4301.	4418.	4536.	4657.	4778.	4902.
Dia	80	81	82	83	84	85	86	87	88	89
Circum	251.3	254.5	257.6	260.8	263.9	267.0	270.2	273.3	276.5	279.6
Area	5027.	5153.	5281.	5411.	5542.	5675.	5809.	5945.	6082.	6221.
Dia	90	91	92	93	94	95	96	97	98	99
Circum	282.7	285.9	289.0	292.2	295.3	298.5	301.6	304.7	307.9	311.1
Area	6362.	6504.	6648.	6793.	6940.	7088.	7238.	7390.	7543.	7698.

SINES, COSINES AND TANGENTS

Deg	Sin	Tan	Cos	Deg	Sin	Tan	Cos	Deg	Sin	Tan	Cos
0	0.0000	0.0000	1.0000	30	0.5000	0.5774	0.8660	60	0.8660	1.732	0.5000
1	0.0175	0.0175	0.9998	31	0.5150	0.6009	0.8572	61	0.8746	1.804	0.4848
2	0.0349	0.0349	0.9994	32	0.5299	0.6249	0.8480	62	0.8829	1.880	0.4695
3	0.0523	0.0524	0.9986	33	0.5446	0.6494	0.8387	63	0.8910	1.962	0.4540
4	0.0698	0.0699	0.9976	34	0.5592	0.6745	0.8290	64	0.8988	2.050	0.4384
5	0.0872	0.0875	0.9962	35	0.5736	0.7002	0.8192	65	0.9063	2.145	0.4226
6	0.1045	0.1051	0.9945	36	0.5878	0.7265	0.8090	66	0.9135	2.246	0.4067
7	0.1219	0.1228	0.9925	37	0.6018	0.7536	0.7986	67	0.9205	2.356	0.3907
8	0.1392	0.1405	0.9903	38	0.6157	0.7813	0.7880	68	0.9272	2.475	0.3746
9	0.1564	0.1584	0.9877	39	0.6293	0.8098	0.7771	69	0.9336	2.605	0.3584
10	0.1736	0.1763	0.9848	40	0.6428	0.8391	0.7660	70	0.9397	2.748	0.3420
11	0.1908	0.1944	0.9816	41	0.6561	0.8693	0.7547	71	0.9455	2.904	0.3256
12	0.2079	0.2126	0.9781	42	0.6691	0.9004	0.7431	72	0.9511	3.078	0.3090
13	0.2250	0.2309	0.9744	43	0.6820	0.9325	0.7314	73	0.9563	3.271	0.2924
14	0.2419	0.2493	0.9703	44	0.6947	0.9657	0.7193	74	0.9613	3.487	0.2756
15	0.2588	0.2679	0.9659	45	0.7071	1.0000	0.7071	75	0.9659	3.732	0.2588
16	0.2756	0.2867	0.9613	46	0.7193	1.0355	0.6947	76	0.9703	4.011	0.2419
17	0.2924	0.3057	0.9563	47	0.7314	1.0724	0.6820	77	0.9744	4.331	0.2250
18	0.3090	0.3249	0.9511	48	0.7431	1.1106	0.6691	78	0.9781	4.705	0.2079
19	0.3256	0.3443	0.9455	49	0.7547	1.1504	0.6561	79	0.9816	5.145	0.1908
20	0.3420	0.3640	0.9397	50	0.7660	1.1918	0.6428	80	0.9848	5.671	0.1736
21	0.3584	0.3839	0.9336	51	0.7771	1.2349	0.6293	81	0.9877	6.314	0.1564
22	0.3746	0.4040	0.9272	52	0.7880	1.2799	0.6157	82	0.9903	7.115	0.1392
23	0.3907	0.4245	0.9205	53	0.7986	1.3270	0.6018	83	0.9925	8.144	0.1219
24	0.4067	0.4452	0.9135	54	0.8090	1.3764	0.5878	84	0.9945	9.514	0.1045
								85	0.9962	11.430	0.0872
25	0.4226	0.4663	0.9063	55	0.8192	1.4281	0.5736	86	0.9976	14.301	0.0698
26	0.4384	0.4877	0.8988	56	0.8290	1.4826	0.5592	87	0.9986	19.081	0.0523
27	0.4540	0.5095	0.8910	57	0.8387	1.5399	0.5446	88	0.9994	28.636	0.0349
28	0.4695	0.5317	0.8829	58	0.8480	1.6003	0.5299	89	0.9998	57.290	0.0175
29	0.4848	0.5543	0.8746	59	0.8572	1.6643	0.5150	90	1.0000	.....	0.0000

TYPICAL PROBLEMS

The following examples show practical uses for these tables.

EXAMPLE 1. How many cu. ft. in a block $6\frac{3}{4}$ by $4\frac{5}{8}$ by $2\frac{5}{16}$ in.?

Solution: Convert inches to feet and multiply, using formula, page 79 for rectangular solid. Use *Inches to Foot Decimals* and *Inch Fractions to Foot Decimals* tables to convert.

$6\frac{3}{4}$ in. = 0.5000 + 0.0625 = 0.5625 ft

$4\frac{5}{8}$ in. = 0.3333 + 0.0521 = 0.3854 ft

$2\frac{5}{16}$ in. = 0.1667 + 0.0260 = 0.1927 ft

Rounding off and multiplying:

$0.56 \times 0.38 \times 0.19 = 0.040$ cu ft.

EXAMPLE 2. What is weight per ft of wrought-iron hex rod 2 in. across flats? Wrought iron weighs 0.28 lb per cu in

Solution: Section area, using formula, page 78, is

$0.866 \times 2 \times 2 = 3.46$ sq in.

Volume per ft is $12 \times 3.46 = 41.5$ cu in.

Weight per ft is $0.28 \times 41.5 = 11.6$ lb.

EXAMPLE 3. A circular pit, 10 ft deep and 3 ft across the hole, has concrete wall 6 in. thick. How many cu ft of concrete are there in the wall?

Solution: Inside section area from table above is 7.069 sq ft. Outside diameter is 4 ft, so outside section area

SQUARE ROOTS AND SQUARES

Diameters by 1/8-in. steps up to 10 in.

Dia	0-1/8	0-1/4	0-3/8	0-1/2	0-5/8	0-3/4	0-7/8
Circum	0.393	0.785	1.178	1.571	1.963	2.356	2.749
Area	0.012	0.049	0.110	0.196	0.307	0.442	0.601
Dia 1	1-1/8	1-1/4	1-3/8	1-1/2	1-5/8	1-3/4	1-7/8
Circum 3.142	3.534	3.927	4.320	4.712	5.105	5.498	5.890
Area 0.785	0.994	1.224	1.485	1.767	2.074	2.405	2.761
Dia 2.	2-1/8	2-1/4	2-3/8	2-1/2	2-5/8	2-3/4	2-7/8
Circum 6.283	6.676	7.069	7.461	7.854	8.247	8.639	9.032
Area 3.142	3.547	3.976	4.430	4.909	5.412	5.940	6.492
Dia 3	3-1/8	3-1/4	3-3/8	3-1/2	3-5/8	3-3/4	3-7/8
Circum 9.425	9.817	10.21	10.60	11.00	11.39	11.78	12.17
Area 7.069	7.670	8.296	8.946	9.621	10.32	11.04	11.79
Dia 4	4-1/8	4-1/4	4-3/8	4-1/2	4-5/8	4-3/4	4-7/8
Circum 12.57	12.96	13.35	13.74	14.14	14.53	14.92	15.32
Area 12.57	13.36	14.19	15.03	15.90	16.80	17.72	18.67
Dia 5	5-1/8	5-1/4	5-3/8	5-1/2	5-5/8	5-3/4	5-7/8
Circum 15.71	16.10	16.49	16.89	17.28	17.67	18.06	18.46
Area 19.63	20.63	21.65	22.69	23.76	24.85	25.97	27.11
Dia 6	6-1/8	6-1/4	6-3/8	6-1/2	6-5/8	6-3/4	6-7/8
Circum 18.85	19.24	19.63	20.03	20.42	20.81	21.21	21.60
Area 28.27	29.46	30.68	31.92	33.18	34.47	35.78	37.12
Dia 7	7-1/8	7-1/4	7-3/8	7-1/2	7-5/8	7-3/4	7-7/8
Circum 21.99	22.38	22.78	23.17	23.56	23.95	24.35	24.74
Area 38.48	39.87	41.28	42.72	44.18	45.66	47.17	48.71
Dia 8	8-1/8	8-1/4	8-3/8	8-1/2	8-5/8	8-3/4	8-7/8
Circum 25.13	25.53	25.92	26.31	26.70	27.10	27.49	27.88
Area 50.27	51.85	53.46	55.09	56.75	58.43	60.13	61.86
Dia 9	9-1/8	9-1/4	9-3/8	9-1/2	9-5/8	9-3/4	9-7/8
Circum 28.27	28.67	29.06	29.45	29.85	30.24	30.63	31.02
Area 63.62	65.40	67.20	69.03	70.88	72.76	74.66	76.59

BE PRACTICAL—DON'T FIGURE TOO FINE FOR THE JOB. WATCH DECIMAL POINTS. DOUBLE CHECK ALL RESULTS BY COMMON SENSE

No.	Rt	Sq
1.0	1.000	1.00
1.1	1.049	1.21
1.2	1.095	1.44
1.3	1.140	1.69
1.4	1.183	1.96
1.5	1.225	2.25
1.6	1.265	2.56
1.7	1.304	2.89
1.8	1.342	3.24
1.9	1.378	3.61
2.0	1.414	4.0
2.1	1.449	4.41
2.2	1.483	4.84
2.3	1.517	5.29
2.4	1.549	5.76
2.5	1.581	6.25
2.6	1.612	6.76
2.7	1.643	7.29
2.8	1.673	7.84
2.9	1.703	8.41
3.0	1.732	9.0
3.1	1.761	9.61
3.2	1.789	10.24
3.3	1.817	10.89
3.4	1.844	11.56
3.5	1.871	12.25
3.6	1.897	12.96
3.7	1.924	13.69
3.8	1.949	14.44
3.9	1.975	15.21
4.0	2.000	16.0
4.1	2.025	16.81
4.2	2.049	17.64
4.3	2.074	18.49
4.4	2.098	19.36
4.5	2.121	20.25
4.6	2.145	21.16
4.7	2.168	22.09
4.8	2.191	23.04
4.9	2.214	24.01
5.0	2.236	25.0
5.1	2.258	26.01
5.2	2.280	27.04
5.3	2.302	28.09
5.4	2.324	29.16
5.5	2.345	30.25
5.6	2.366	31.36
5.7	2.387	32.49
5.8	2.408	33.64
5.9	2.429	34.81
6.0	2.449	36.0
6.1	2.470	37.21
6.2	2.490	38.44
6.3	2.510	39.69
6.4	2.530	40.96
6.5	2.550	42.25
6.6	2.569	43.56
6.7	2.588	44.89
6.8	2.608	46.24
6.9	2.627	47.61
7.0	2.646	49.0
7.1	2.665	50.41
7.2	2.683	51.84
7.3	2.702	53.29
7.4	2.720	54.76
7.5	2.739	56.25
7.6	2.757	57.76
7.7	2.775	59.29
7.8	2.793	60.84
7.9	2.811	62.41
8.0	2.828	64.0
8.1	2.846	65.61
8.2	2.864	67.24
8.3	2.881	68.89
8.4	2.898	70.56
8.5	2.915	72.25
8.6	2.933	73.96
8.7	2.950	75.69
8.8	2.966	77.44
8.9	2.983	79.21
9.0	3.000	81.0
9.1	3.017	82.81
9.2	3.033	84.64
9.3	3.050	86.49
9.4	3.066	88.36
9.5	3.082	90.25
9.6	3.098	92.16
9.7	3.114	94.09
9.8	3.130	96.04
9.9	3.146	98.01
10	3.162	100
11	3.317	121
12	3.464	144
13	3.606	169
14	3.742	196
15	3.873	225
16	4.000	256
17	4.123	289
18	4.243	324
19	4.359	361
20	4.472	400
21	4.583	441
22	4.690	484
23	4.796	529
24	4.899	576
25	5.000	625
26	5.099	676
27	5.196	729
28	5.292	784
29	5.385	841
30	5.447	900
31	5.568	961
32	5.657	1024
33	5.745	1089
34	5.831	1156
35	5.916	1225
36	6.000	1296
37	6.083	1369
38	6.164	1444
39	6.245	1521
40	6.325	1600
41	6.403	1681
42	6.481	1764
43	6.557	1849
44	6.633	1936
45	6.708	2025
46	6.782	2116
47	6.856	2209
48	6.928	2304
49	7.000	2401
50	7.071	2500
51	7.141	2601
52	7.211	2704
53	7.280	2809
54	7.348	2916
55	7.416	3025
56	7.483	3136
57	7.550	3249
58	7.616	3364
59	7.681	3481
60	7.746	3600
61	7.810	3721
62	7.874	3844
63	7.937	3969
64	8.000	4096
65	8.062	4225
66	8.124	4356
67	8.185	4489
68	8.246	4624
69	8.307	4761
70	8.367	4900
71	8.426	5041
72	8.485	5184
73	8.544	5329
74	8.602	5476
75	8.660	5625
76	8.718	5776
77	8.775	5929
78	8.832	6084
79	8.888	6241
80	8.944	6400
81	9.000	6561
82	9.055	6724
83	9.110	6889
84	9.165	7056
85	9.220	7225
86	9.274	7396
87	9.327	7569
88	9.381	7744
89	9.434	7921
90	9.487	8100
91	9.539	8281
92	9.592	8464
93	9.644	8649
94	9.695	8836
95	9.747	9025
96	9.798	9216
97	9.849	9409
98	9.899	9604
99	9.950	9801

from table is 12.57 sq ft. Section area of wall is 12.57 − 7.069 = 5.5 sq ft. Volume = 10 × 5.5 = 55 cu ft.

EXAMPLE 4. What is the volume of a right circular cone, 10 ft across at the base, if the cone slopes up at an angle of 50 deg from the horizontal?

Solution: First find the height. Use formula, $a = b \times \tan A$, from page 77. Tan 50 deg is 1.19; b is half the diameter or 5 ft. Height is 5 × 1.19 = 5.95 ft. Area of base from table is 78.54 sq ft. Volume = ⅓ × 78.54 × 5.95 = 156 cu ft.

EXAMPLE 5. How long is the guy wire stretching from the top of a 30 ft pole to anchor 15 ft from the pole's base?

Solution: Using the rule for right triangles shown on page 76: $c^2 = a^2 + b^2$. 30 squared is 900; 15 squared is 225; 900 + 225 = 1125. To find square root of 1125, move decimal two places to left to get 11.25. Square root of 11 is 3.317; square root of 12 is 3.464; difference is 0.147; 0.25 × 0.147 = 0.037. Square root of 11.25 equals 3.317 + 0.037 = 3.35. Move decimal point back one place to get square root of 1125 = 33.5 ft of guy wire.

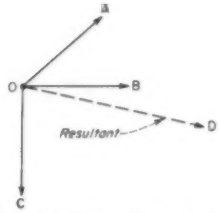
EXAMPLE 6. Roughly how many sq. ft. of heat-transfer area are there in a shell-and-coil heat exchanger made with 30 closely spaced turns of ¼-in. outside-diameter tubing if the coil is 1 ft in center-line diameter?

Solution: The length of each turn will be just a little more than the circumference of a 1-ft diameter circle, or 3.2 ft. (Formula page 76 shows circumference equals 3.1416 times diameter.) Length of coil is then 30 × 3.2 = 96 ft. Diameter of tubing in feet from table page 79 is 0.0208. Circumference of tubing is 3.14 × 0.0208 = 0.065 ft. Outside area of tubing is 96 × 0.065 = 6.2 sq ft of heat-transfer area.

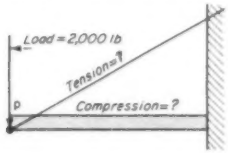
MECHANICS & MECHANISMS

VECTORS EXPLAINED

A VECTOR is an arrow showing direction and amount of a movement, velocity or force. Arrow's length, which stands for amount, may be to any convenient scale. For example, vector above might represent a 5-mi walk slightly north of east

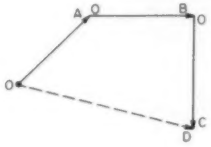


TO ADD VECTORS, rearrange them end to end (right, above) with arrows running

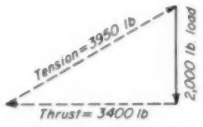


TO FIND tension in tie rod, compression in jib, draw 2000-lb vector down to rep-

Jib-crane problem below typifies engineering use of vectors. Forces acting at point *P* must balance, since it does not move. Resultant must be zero, so vector diagram is closed triangle. Knowing directions of forces and amount of load, draw diagram to scale. Values of tension and thrust can then be picked off to same scale.

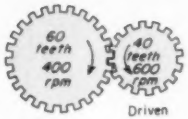


same way. Resultant is line OD from heel of the first vector to point of last

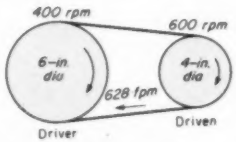


resent load. Draw other vectors in direction of tie and jib. Then scale off values

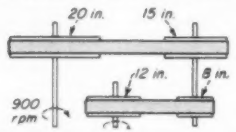
PULLEYS, GEARS



GEAR RPM's vary inversely as number of teeth. In diagram, tooth ratio is 6 to 4, so rpm ratio is 4 to 6. For pulleys, the rpm's vary inversely as the diameters

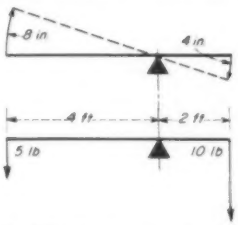


BELT SPEED is circumference of either pulley × its rpm. For 6-in. (0.5 ft) pulley, circumference is 3.14 × 0.5 = 1.57 ft. So belt speed is 400 × 1.57 = 628 fpm

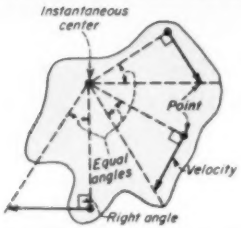


FOR TRAINS of pulleys or gears, rpm of first driver times ratios for all the pairs gives final speed. Here, it comes to 900 × 20/15 × 8/12, equals 800 rpm

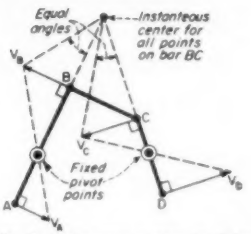
LEVERS, LINKAGES, INSTANTANEOUS CENTERS



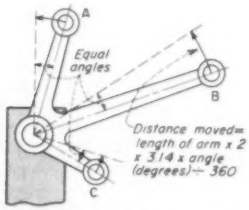
LEVER LAWS: Distance moved is *directly*, and force is *inversely*, proportional to distance from the fulcrum — see diagram



INSTANTANEOUS CENTER: At any given instant all points in any moving body are rotating about a single point called



the *instantaneous center*. In 3-bar linkage, *right*, center of BC is where extensions of levers *AB* and *CD* intersect



MOVEMENT of any point in rotating body is proportional to distance from axis

Three-bar linkage, at right above, shows application of laws of levers, rotating bodies, instantaneous centers. *AB* and *CD* are rigid levers with fixed pivots. Bar *BC* connects them, jointed at *B* and *C*. If point *A* moves with velocity V_1, what is velocity of *D*?

Velocities at *A* and *B* are proportional to distances from pivot. Triangles give us V_B. To find velocity of *C*, we must get instantaneous center of *BC*. Point *B* moves at right angles to *AB*, so one instantaneous radius of *BC* must lie along *AB* extended. Extending *DC* gives us another such radius. Intersection is instantaneous center.

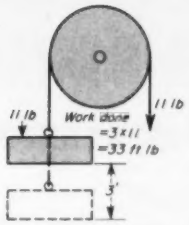
Velocities at *B* and *C* are in proportion to distances from instantaneous center. Having found V_C, we get V_D by proportion, as we got V_B from V_A.

WORK AND FORCE

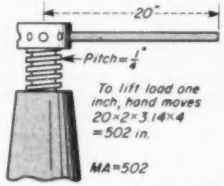
When a force acts on a moving body, force (pounds) times distance body moves (feet) equals work done (foot pounds). Sketch at right illustrates this: Force of 11 lb at end of rope lifts weight 3 ft. Work done is 33 ft lb. Neglecting friction, work put in equals work delivered.

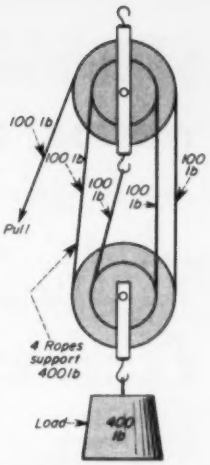
Some mechanical devices increase force at expense of distance moved. Screw jack at right must turn four times to lift load one inch. Force applied at end of handle moves 502 in. in those four turns. Assuming no friction, work in equals work out. Hence forces will be inversely proportional to distances — one lb at end of handle would theoretically lift 502 lb. This ratio — 502 to 1 — is called *mechanical advantage*.

Familiar block and fall is another device for increasing force at the expense of distance moved. An easy way to find the mechanical advantage is to count number of strands of rope leading to the lower block. Thus mechanical advantage in sketch at right is 4, and 100 lb pull will lift 400 lb.



WORK DONE in lifting 11 lb three ft is 33 ftlb





MECHANICAL ADVANTAGE of jack and block-and-fall is obtained by "trading" distance moved to increase force

TORQUE AND POWER

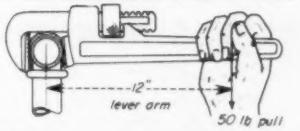
Energy is defined as *capacity* for doing work. It is measured in same units as work and for all practical purposes may be considered interchangeable. Energy takes two forms: *potential* and *kinetic*. Weight in sketch above has 33 ft lb of potential energy when it is in raised position, because it could do that much work if allowed to fall 3 ft. In the course of such a fall, potential energy gets less as height above table gets less. Just before it hits, all potential energy is gone and weight then has 33 ft lb of kinetic energy due to its motion. Theoretically, it will deliver that much work when it hits.

While *work* and *energy* can be used interchangeably without much harm, the term *power* differs and the difference should be clearly grasped. Power is the *rate* of doing work. Look again at the sketch of the weight. If we take one minute to raise it, power needed is 33 ft lb per min. If we allow ten minutes for the job, it takes only one-tenth as much power (3.3 ft per min). Power may be measured in ft lb per min, as we've just seen, or ft lb per sec. Engineers, however, are more familiar with *horsepower* and *kilowatts*. One horsepower means doing work at a rate of 550 ft lb per sec or 33,000 ft lb per min. Thus 33 ft lb per min of example above would be 0.001 hp. One kilowatt is 1.34 hp.

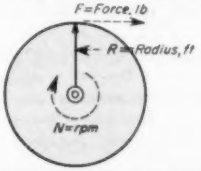
A *torque* is a twisting effort, usually measured in pound inches. For example, if you pull 50 lb on the end of a 12-in. wrench handle, you exert a torque of 600 lb in. For rotating machinery, we bring in a time factor to relate torque and horsepower. Formula for power is: horsepower = 159 × rpm × torque (lb in.) ÷ 10,000,000. To get torque from a given speed and horsepower, multiply hp by 10,000,000 and divide by 159 times the rpm.

In sketch at right, engine turning 190 rpm is loaded with a prony brake. Brake load is 50 lb at 24 in. radius. Torque is 50 × 24, or 1200 lb in. Putting this in formula gives 159 × 190 × 1200 ÷ 10,000,000, or 3.6 hp.

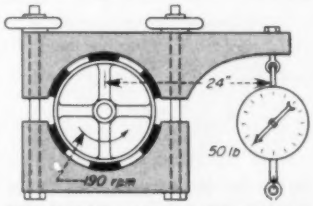
If horsepower and kilowatts are power units, what are *horsepowerhours* and *kilowatthours*? They're units for measuring energy. One horsepowerhour simply means doing 33,000 ft lb per min for 60 min. This is 33,000 × 60 = 1,980,000 ft lb, work or energy.



TORQUE, or twisting effort, is force times the lever arm over which it acts



HORSEPOWER formula may be expressed as: Hp = 19 x N x R (ft) X F/100,000

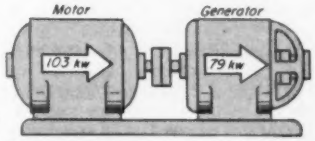


PRONY BRAKE with 50-lb load at 24 in. radius calculates to 3.6 hp at 190 rpm

EFFICIENCY

Efficiency of any machine is its output divided by its input, measured in the *same* units of work or power. Sketch at right shows a simple case. We find the input to be 103 kw and the output to be 79 kw. Dividing 79 by 103, we get 0.767. Since efficiency is usually expressed in percent, we multiply by 100 to get 76.7%. Note that this is the *over-all* efficiency of the complete mg set.

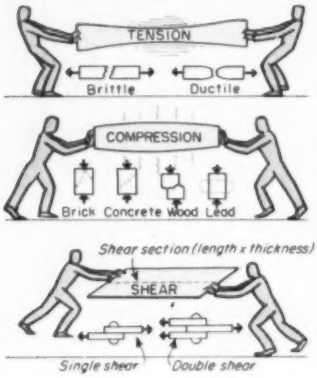
To find the efficiency of a motor alone, a manufacturer might connect it to an electric dynamometer. This would give output in kw. He'd measure input by a wattmeter and thus get it in the same units. Then simple division, as above, would give the answer. Gen eff = total eff ÷ motor eff.



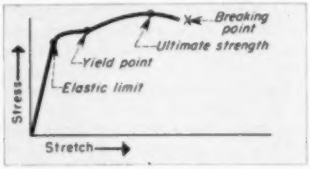
OVER-ALL EFFICIENCY of motor-generator set is 79/103 = 0.767, which is 76.7%

STRENGTH OF MATERIALS

TENSION, COMPRESSION, SHEAR

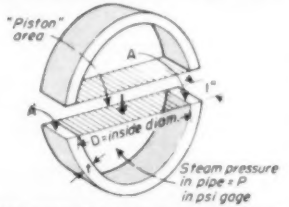


Force applied to material can be (1) push, *compression* (2) pull, *tension* (3) scissor-like action called *shear*. All materials give with force; too much they break. Engineers often work with *stress* in psi rather than force in lb. Stress equals lb force divided by section area in sq in. Curve shows how tension affects ductile materials. Below *elastic limit*, material stretches in proportion to stress. If stress is removed, material returns to original size and shape. Beyond elastic limit, stress gives *permanent set*. At *yield point*, material begins to flow with no increase in unit stress (actual force over *original* section area). *Ultimate strength* is force *just* before breaking over *original* section area. *Yield strength* is stress producing 0.2% permanent set. *Factor of safety* is ultimate strength over allowable or working stress. Annealed carbon steel has yield strength of 40,000 psi and tensile (ultimate) strength of 60,000 psi.



DUCTILE MATERIALS stretch under tension, brittle materials give little before break

STRESS IN SHELLS

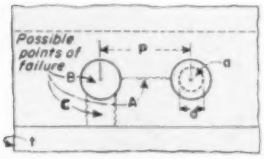


ALLOWABLE PRESSURE = safe stress × 2 × wall thickness ÷ inside diameter

In a seamless or welded tube or drum under internal pressure, tendency to split lengthwise ("unroll") is twice the tendency to split around. For that reason, stress is always figured for a (lengthwise) split instead of a circumferential split. Sketch shows how to translate internal pressure into stress. Fluid pressure tends to split tube in half. Force on "*piston area*" equals pressure *P*, psig, times diameter *D*, inches. This force is resisted by the two metal sections *A*. Resisting force equals 2 times the thickness *t* times the unit stress *s*.

EXAMPLE: What is allowable pressure for seamless shell, 30-in. inside diameter, 0.5-in. thick wall; 15,000-psi safe stress? Safe pressure is $2 \times 0.5 \times 15000 \div 30 = 500$ psi. With 80% efficient longitudinal riveted seam, safe pressure is $0.8 \times 500 = 400$ psi.

RIVETED JOINTS



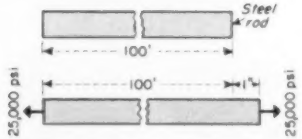
JOINTS FAIL (A) between holes, (B) by rivet shearing, or (C) in front of rivet

Strength of a joint is usually figured as its *efficiency* – the strength of its weakest point divided by the strength of the solid plate.

FIGURING EFFICIENCY. Here's method for single-riveted lap joint. (ASME code shows method for more complicated joints.) What is efficiency of the joint in sketch if pitch *P* is 1⅝ in., plate thickness *t* is ¾ in., rivet hole diameter *d* is 11/16 in., area of rivet *a*, after driving, rivet strength in single shear *s* is 44,000 psi, crushing strength of plate *c* is 95000 psi, tensile strength of plate *TS* is 55,000 psi?

Strength of plate $= TS \times t \times P = 22{,}300$
Strength at $A = (P\text{-}d)\ t \times TS = 12{,}900$
Strength at $B = s \times a = 16{,}300$
Strength at $C = d \times t \times c = 16{,}300$
Efficiency $= 12{,}900 \div 22{,}300 = 0.577$

STRETCHING OF MATERIALS



HEATING to expand 1 in., then gripping rod so it cannot contract when it cools will also set up 25,000-psi tensile stress

When a material is stretched or compressed (within elastic limit) ratio of applied stress, psi, over unit change (in. per in.) in length is a constant called modulus of elasticity. Elongation (inches) = length (inches) × stress (psi) ÷ modulus. (See page 82 for thermal expansion, page 101 for expansion of pipes.)

ELASTICITY AND STRETCH FOR COMMON METALS

Material	Modulus of elasticity (million psi)	Stress, psi, to stretch 1 in./100 ft
Aluminum	10	8300
Copper	16	13,000
Iron	18	15,000
Steel	30	25,000
Wood (approx)	1.5	1250

BEAM SIZES

For steel "I" beams, safe moment equals modulus times 20,000 psi. See below right for long beams

Wide-flange "I" Beams

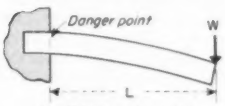
Depth	Weight	Modulus	Limiting Length
8	17	14.1	10.1
8	20	17.0	12.2
8	24	20.8	16.3
8	28	24.3	18.8
8	31	27.4	21.6
8	35	31.1	24.4
10	21	21.5	9.9
10	25	26.4	12.3
10	29	30.8	14.2
10	33	35.0	17.6
10	39	42.2	21.2
10	45	49.1	24.5
10	49	54.6	27.9
12	27	34.1	10.9
12	31	39.4	12.5
12	36	45.9	14.5
12	40	51.9	17.3
12	45	58.2	19.2
12	50	64.7	21.2
14	30	41.8	9.3
14	34	48.4	10.9
14	38	54.6	12.3
14	43	62.7	15.4
14	48	70.2	17.2

Standard "I" Beams

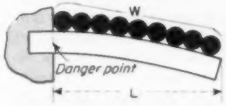
Depth	Weight	Modulus	Limiting Length
3	5.7	1.7	10.1
3	7.5	1.9	10.8
4	7.7	3.0	9.7
4	9.5	3.3	10.2
5	10.9	4.8	9.8
5	14.7	6.0	10.7
6	12.5	7.3	10.0
6	17.2	8.7	10.7
7	15.3	10.4	10.2
7	20.0	12.0	10.8
8	18.4	14.2	10.6
8	23.0	16.0	11.1
10	25.4	24.4	11.4
10	35.0	29.2	12.1
12	31.8	36.0	11.3
12	35.0	37.8	11.5
12	40.8	44.8	14.4
12	50.0	50.3	15.4
15	42.9	58.9	11.4
15	50.0	64.2	11.7

BEAM FORMULAS

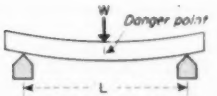
L is inches W is total load in pounds



MOMENT = L × W



MOMENT = ½ × L × W

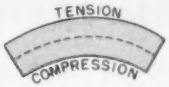


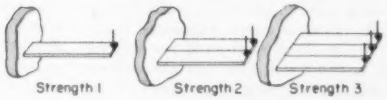
MOMENT = ¼ × L × W

MOMENT = ⅛ × L × W

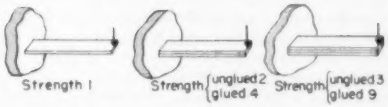
FACTS ABOUT BEAMS

When a beam is bent, convex fibers are stretched under tension; bottom (concave) fibers are shortened by compression





Strength of beam is directly proportional to its width. Three planks side by side take triple load



Strength is also proportional to square of depth. Three planks stacked, glued, take nine times load

SECTION MODULUS

(MOMENT = MODULUS × STRESS)

RECTANGLE: Modulus equals width x depth squared ÷ 6

SOLID CIRCLE (rod): Modulus equals 1/10 diameter cubed

HOLLOW CIRCLE (tube) Modulus equals 8/10 wall thickness x average diameter squared*

FIGURING LONG BEAMS

To figure safe moment of I beams longer than limiting length, reduce stress of 20,000 psi by fraction of limiting length over total length

SAFE STRESSES

Structural steel	**20,000 psi**
Any common structural timber	**600 to 1400 psi**

*For section modulus of commercial pipe sizes see last column of table on page 99

BEAM PROBLEMS

EXAMPLE: What size I beam will span a 10-ft (120-in.) gap to support an evenly distributed 50,000-lb load?

Solution. Moment = ⅛ × 120 × 50,000 = 750,000 in. lb. With safe stress of 20,000 psi, minimum modulus of beam equals 750,000 ÷ 20,000 = 37.5. Use either 12-in. 31-lb-per-ft wide-flange beam or 12-in. 35-lb-per-ft standard I beam to support the load.

EXAMPLE: How much weight will a 6-in., 12.5-lb-per-ft standard I beam, 15 ft long, used as a cantilever, support on one end?

Solution. Limiting length is only 10.0 ft, so reduce allowable stress of 20,000 psi by multiplying by 10.0 ÷ 15 to get 13,300-psi safe stress. Modulus is 7.3, so safe moment is 13,300 × 7.3 = 97,000 in. lb. Safe load is then 97,000 ÷ 15 = 6470 lb.

CAUTION. Use the bending formulas with caution, particularly if the beam is shorter than twice its depth or is slender, wobbly and unbraced. Call in a structural engineer to design any permanent beam installations.

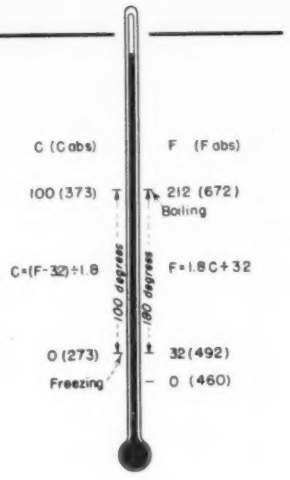
FUNDAMENTALS OF HEAT

TEMPERATURE

Heat is one common form of energy. Heat added to a body makes it hotter; removing heat cools it. Heat also melts solids into liquids and converts liquids into vapors or gases. Expansion is another result of heating, as are welding of metallic materials and also certain chemical reactions. Heat energy can be turned into mechanical energy to do work. But practically all mechanical, electrical or chemical energy used to do work eventually ends up as heat through friction and other losses.

HOT AND COLD. Temperature is a measure of how much hotter or colder one body is than another. While temperature is *not* a direct measure of heat, it measures a *result* of heat sometimes called *sensible heat* or heat level. The hotter a body, that is, the higher its temperature, the higher the heat level. Temperature is called a measure of heat level because heat, like water will flow naturally only downhill, from a hotter body to a colder one.

MEASURING TEMPERATURE. In most engineering work, temperature is measured on the Fahrenheit scale, on which 32 F is freezing and 212 F boiling point of water at sea level. On the centigrade scale, 0 C is freezing and 100 C boiling. Fahrenheit *absolute* scale (sometimes called Rankine, in deg R) uses Fahrenheit degrees starting from absolute zero. Centigrade *absolute* scale (Kelvin scale in deg K) uses Centigrade degrees starting from absolute zero. *Absolute zero* is the temperature where molecules stop moving. It is equivalent to −460 F or −273 C.



BRITISH THERMAL UNIT (BTU), SPECIFIC HEAT

Standard unit of heat is the British thermal unit, or Btu. It is defined as 1/180 of the heat supplied to raise the temperature of 1 lb of water from 32 F to 212 F. For all practical purposes this means 1 Btu is the heat supplied to raise the temperature of 1 lb of water 1 deg F.

SPECIFIC HEAT. If objects of the same weight, but of different materials, receive the same amount of heat, they will heat up to different temperatures. How much each object's temperature will rise depends on the *specific heat* of the material. Specific heat is the heat required to raise the temperature of 1 lb of a substance 1 deg F. By definition of the Btu, the specific heat of water is 1. All other specific heats are relative to this. Heat supplied = lb × sp heat × temp rise. Warming 100 lb of fuel oil from 40 to 100 F takes about 100×0.5×60=3000 Btu.

Specific heats change with temperature, but often can be assumed constant within the practical range of temperatures. For gases there are two specific heats, one for heating at constant pressure and another for heating at constant volume (in closed tank). In most cases, volume and pressure change; here use "gas laws," next page.

SPECIFIC HEATS
(Btu per lb per deg F, Average)

Acetone	0.51	Gasoline	0.53
Asbestos	0.25	Glass	0.16 to 0.2
Asphalt	0.22	Iron	0.12
Bakelite	0.3 to 0.4	Kerosene	0.47
Benzene	0.41	Limestone	0.22
Brickwork	0.2	Marble	0.21
Carbon tet	0.19	Petroleum	about 0.5
Cement	0.18	Sand	0.19
Coal	0.26 to 0.37	Steel	0.12
Coke	0.26 to 0.40	Stone	0.2
Concrete	0.15	Turpentine	0.42
Ethyl alcohol	0.68	Wood	0.45 to 0.65

	Constant pressure	Constant volume
Air	0.241	0.172
Carbon dioxide	0.205	0.160
Hydrogen	3.42	2.44
Methane	0.59	0.47

EXPANSION OF SOLIDS, LIQUIDS

Adding heat to substances makes them expand; removing heat makes them contract. Within normal temperature ranges, solids or liquids expand or contract in proportion to the temperature change. To figure expansion or contraction, multiply original length × expansion coefficient × temperature change. Heating 30-in. steel bar, 40 deg F, expands it 30×40×.0000067=0.008 in.

Heating or cooling an object *without* letting it expand or contract sets up stresses. If a rigidly held steel bar is cooled enough that it would shrink 1 in. per 100 ft, if allowed, same tensile stress is set up as if bar were stretched 1 in. (see "Stretching of Materials" page 84).

AVERAGE EXPANSION COEFFICIENTS
(Parts per million per deg F)

Material	Linear	Cubical	Material	Linear	Cubical
Aluminum	12.3	36.9	Steel, SAE 1020	6.7	20.1
Brass, cast	10.4	31.2	stainless, 301	9.4	28.2
Bronze	10.2	30.6	Wood, oak**	2.7	8.1
Cement, neat	6.0	18.0	Wood, oak***	30.2	90.6
Concrete	8.0	24.0	Wood, pine**	3.0	9.0
Copper	9.2	27.6	Wood, pine***	18.9	56.7
Glass, tube	4.6	13.8			
Glass, plate	4.9	15.6	Acetone		826
Glass, Pyrex	1.8	5.4	Alcohol, ethyl		622
Ice*	28.3	84.9	Benzine		687
Iron, cast	6.3	18.9	Carbon tetrachloride		687
Iron, wrought	6.7	20.1	Mercury		101
Marble	6.5	19.5	Petroleum, Penna.		500
Masonry	2.5 to 5.0	7.5 to 15	Petroleum, Calif.		430
Monel	7.8	23.4	Petroleum, Texas		420
Silicon	4.2	12.6	Turpentine		541
Steel, alloy cast	6.7	20.1	Water		115

* Average -4 to +30 F. ** Parallel to grain *** Across grain

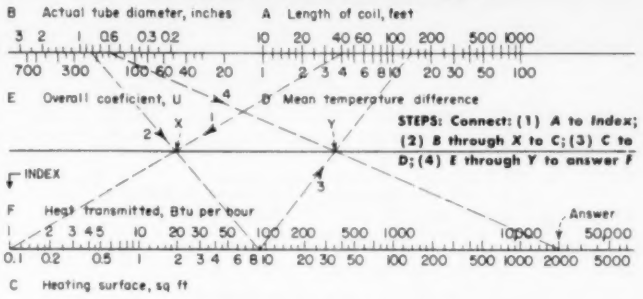
HEAT TRANSFER

Heat flows from a warm area to a cooler one by three different methods: (1) by *conduction* from molecule to molecule within a substance or between touching substances (2) by *radiation* or heat waves (3) by *convection* or eddy currents in or movements of liquids and gases. In practical engineering work, heat transfer is usually by two or all three methods. Net effect is often hard to predict and depends on the way fluids flow along the transfer surfaces and the shape and material of the transfer surface. Rapid flow increases heat transfer.

U FACTOR. For practical purposes, engineers often lump the above factors into an over-all "coefficient of heat transfer" called the *U factor*. (Btu per hr per sq ft per deg F temp difference). Each particular design of heat exchanger has a certain U factor for a particular service. As table shows, these factors vary widely. Heat transfer, Btu per hr = U factor × transfer area, sq ft, × mean temp difference.

PROBLEM. Use chart to find heat transfer through wall of a 40-ft coil of 0.825-in. tubing if mean temperature difference is 14 F and U factor is 160. Dashed lines show method. Answer is 19,500 Btu per hour.

FIGURING HEAT TRANSFER


B Actual tube diameter, inches
A Length of coil, feet
E Overall coefficient, U
D Mean temperature difference
STEPS: Connect: (1) A to Index; (2) B through X to C; (3) C to D; (4) E through Y to answer F
INDEX
F Heat transmitted, Btu per hour
Answer
C Heating surface, sq ft

RANGE OF U FACTORS

(Btu per hr per sq ft per deg F)

Type of heat exchanger	U, free convection	U, forced convection	Typical fluid	Typical apparatus
Liquid to liquid	25-60	150-300	Water	Liquid-to-liquid heat exchanger
Liquid to liquid	5-10	20-50	Oil	
Liquid to gas (atm pressure)	1-3	2-10		Hot-water radiators
Liquid to boiling liquid	20-60	50-150	Water	Brine coolers
Liquid to boiling liquid	5-20	25-60	Oil	
Gas (atm pressure) to liquid	1-3	2-10		Air coolers, economizers
Gas (atm pressure) to gas	0.6-2	2-6		Steam superheaters
Gas (atm pressure) to boiling liquid	1-3	2-10		Steam boilers
Condensing vapor to liquid	50-200	150-800	Steam-water	Liquid heaters and condensers
Condensing vapor to liquid	10-30	20-60	Steam-oil	
Condensing vapor to liquid	40-80	60-150	Organic vapor-water	
Condensing vapor to liquid		15-300	Steam-gas mixture	
Condensing vapor to gas (atm pressure)	1-2	2-10		Steam pipes in air. Air heaters
Condensing vapor to boiling liquid	40-100			Scale-forming evaporators
Condensing vapor to boiling liquid	300-800		Steam-water	
Condensing vapor to boiling liquid	50-150		Steam-oil	

GAS LAWS

Except near their condensing points, most gases follow these rules:

1. For a given pressure, gas expands in exact proportion to *absolute* temperature ($V_1 \div V_2 = T_1 \div T_2$). (Ex: Tripling abs temp triples volume).

2. For a given volume, the absolute pressure of a gas varies in exact proportion to the absolute temperature ($P_1 \div P_2 = T_1 \div T_2$). (Ex: Raising abs temp 30%, raises abs pressure 30%).

3. For a given temperature, volume of given weight of gas varies inversely as absolute pressure ($P_1 \times V_1 = P_2 \times V_2$). (Ex: Doubling absolute pressure halves volume).

These three rules can be summed up in one rule: $P \times V = k \times T$

P = absolute pressure, lb per sq in.

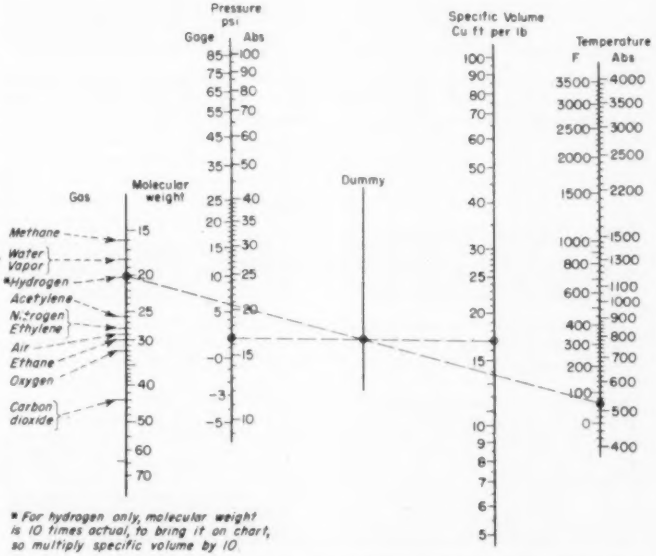
V = specific volume, cu ft per lb

T = absolute temperature, deg F + 460

k = 10.7 ÷ molecular weight of gas (k for air = 0.37)

Chart at right is an easy way to use formula to find specific volume of a gas when pressure and temperature are known.

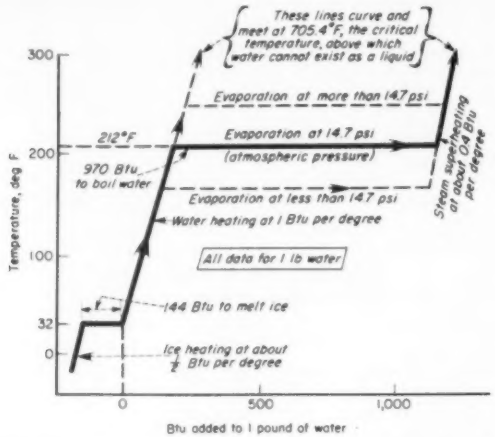
PROBLEM: What is the volume of 1 lb of hydrogen at 70 F and 2 psi gage? Dashed lines show method of solving. Specific volume is 170 cu ft per lb.



*For hydrogen only, molecular weight is 10 times actual, to bring it on chart, so multiply specific volume by 10.

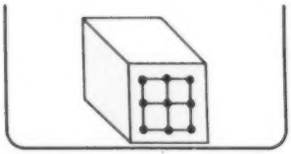
USING GAS CHART. Draw line from gas (or molecular weight) to temperature. Then draw line from pressure through intersection on dummy to find the specific volume. Same construction will determine temperature when the specific volume is known

CHANGE OF STATE

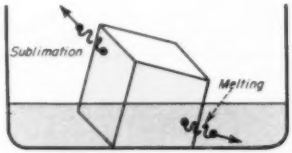

These lines curve and meet at 705.4°F, the critical temperature, above which water cannot exist as a liquid
Evaporation at more than 14.7 psi
212°F
Evaporation at 14.7 psi (atmospheric pressure)
970 Btu to boil water
Evaporation at less than 14.7 psi
Steam superheating at about 0.4 Btu per degree
Water heating at 1 Btu per degree
All data for 1 lb water
144 Btu to melt ice
Ice heating at about ½ Btu per degree
Temperature, deg F
300
200
100
32
0
0
500
1,000
Btu added to 1 pound of water

HOW WATER CHANGES STATE. Solid line shows effect of heating at atmospheric pressure. Lines for ice, water above 212 F and steam are not actually straight lines

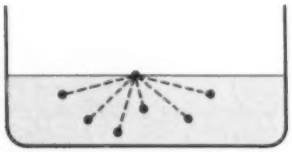
WHEN A SUBSTANCE CHANGES STATE, ITS MOLECULES DO NOT CHANGE, ONLY THEIR RELATION



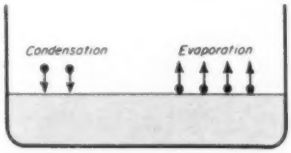
SOLID-STATE molecules are free to move, but are kept in rigid pattern by "tethers" of mutual attraction to form crystals



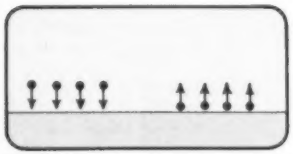
MELTING AND SUBLIMING molecules both need extra dose of energy ("latent heat") to break their attraction tether



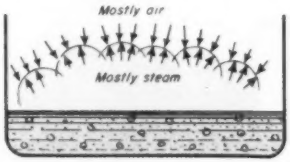
LIQUID SURFACE TENSION caused by unequal pull on molecules at surface by the molecules inside liquid forms a barrier



EVAPORATION, CONDENSATION of individual molecules go on at same time but net effect is usually one or the other



SATURATION IN CLOSED VESSEL. Molecules reentering liquid equal those leaving liquid when temperature is kept constant



BOILING IN OPEN VESSEL takes place when the vapor pressure is equal or greater than external pressure; bubbles form

MOLECULES. All substances are made up of molecules in constant motion. Adding heat speeds up their motion (kinetic energy); removing heat slows it down. At same time molecules pull at each other. This tends to restrict their movement and hold them together in a body. Speeding up motion by adding heat tends to overcome attraction of molecules; so substance expands. Temperature rises as heat is added unless there is a change in state.

SOLID STATE. Energy of moving molecules is small beside attraction; so molecules move as if on tethers.

LIQUID STATE. Molecular movement and attraction are pretty much in balance. Molecules still stick close together but can wander any direction within the liquid. Surface tension of liquids is a result of molecular attraction.

GAS STATE. Molecules are independent of mutual attraction. Travel is limited only by collisions with other molecules or confining walls.

MELTING. When solid is heated to point where molecules move fast enough to break away from rigid pattern, temperature no longer rises with heat until all molecules have broken loose.

SUBLIMATION. In breaking bonds of solid state, some molecules move fast enough to break away from all others to become gas. With carbon dioxide, dry ice *sublimes* directly to gas.

EVAPORATION. In heating liquid, some molecules speed up enough to break right through surface-tension layer, against attraction of molecules in liquid, to become gas. In escaping, gas molecules take away energy ("latent heat"). This may cool liquid.

CONDENSATION. Gas molecules losing heat slow down and pull together as liquid. Molecules close to liquid surface may be pulled in.

SATURATION. To stay as gas, molecules must move fast enough to keep apart. Speed depends on temperature. For every temperature there is a maximum number of molecules that can exist as gas in a given volume. Adding more gas molecules to a given volume of *maximum density* (minimum specific volume) without increasing temperature will increase mutual attraction of molecules enough to start condensation. This *saturation* point always exists where gas and its liquid touch.

VAPOR PRESSURE. Moving gas molecules exert a force on any confining surfaces, called *vapor pressure*. Vapor pressure goes up as the speed and number of molecules, or as temperature, density.

SUPERHEAT. Saturated vapor not in contact with its liquid can be superheated two ways: (1) Increasing its temperature (adding heat) to expand it or (2) decreasing its pressure (throttling) over certain ranges.

STEAM TABLES SIMPLIFIED

MEASURING STEAM

What are the yardsticks for steam? First if we have a fixed amount of steam in a closed space, we can measure weight or volume. Usually we measure steam *flow* in lb per hr.

STEAM PROPERTIES. Certain other measurements identify the *kind* of steam as distinct from the *amount*. These are (1) temperature (2) pressure (3) quality – expressed as percent moisture or percent vapor of wet steam (4) degree of superheat – degrees F above saturation temperature (5) specific volume – cu ft per lb steam (6) enthalpy – Btu per lb (7) entropy and (8) internal energy. The two most commonly measured are temperature and pressure. With these two (plus an estimate of quality in the case of wet steam) the other properties can be read directly from steam tables.

SATURATION PAIRS. When water is boiling, both the water and steam in contact with the water have the same temperature – called the saturation temperature. For each boiling pressure there is only one saturation temperature and vice versa. If you know one you can find the other in the steam tables. Thus for boiling water and steam in contact, 14.7 psi abs and 212 F, 50 psi abs and 281 F, 100 psi abs and 328 F, etc. are saturation pairs.

TABLES. Skeleton tables on the next two pages are not complete enough for everyday practical use, but will serve to show how to use the complete tables, *Thermodynamic Properties of Steam*, by Keenan and Keyes, published by John Wiley & Sons, N. Y. Excerpts shown by permission.

Note that Tables 1 and 2 are for saturated steam only. Table 3 gives data for superheated steam. Columns shown, in the complete tables, for *entropy* and *internal energy* are omitted because they are used mostly for turbine design and theoretical calculations for very-high-pressure plants. Entropy will be discussed in Part Two of this book.

ENTHALPY ("HEAT") DEFINED

For reasons too long to explain here the term "heat content" is in bad repute with the steam experts. The quantities formerly known as the "heat" of liquid, "heat" of evaporation and "total heat" of steam are now technically known as the *enthalpy of the* (saturated) *liquid, enthalpy of evaporation, enthalpy of saturated vapor and enthalpy of the superheated vapor.*

The enthalpy of water or steam is the *heat that must be added, Btu per lb, to bring it from liquid at 32 F to its present temperature, pressure and condition.* Enthalpy of evaporation is the enthalpy difference between saturated liquid and dry saturated vapor.

In Table 1, for example, turn to the line for atmospheric pressure, 14.7 psi abs, corresponding to a saturation temperature of 212 F. Enthalpy of the liquid is given as 180.0 Btu. This means that if you hold 1 lb of water at a constant pressure of 14.7 psi abs and heat it from 32 F to 212 F the heat supplied will be 180 Btu.

For low pressures and temperatures, enthalpy of water can be estimated by subtracting 32 from water temperature. (To reduce error at higher pressures, use saturation tables like those on p 91, or complete ones. For maximum accuracy, use compressed-liquid table. For example, take water at 300 F and 1000 psia. Rule of thumb shows 300 – 32 = 268 Btu, saturation table 269.6. Applying correction from compressed-liquid table gives true 271.4 Btu.)

The same line tabulates the enthalpy of evaporation as 970.4 Btu. This means that (at 14.7 psi abs and 212 F) it takes 970.4 Btu to convert one pound of boiling water into dry saturated steam. If the flow of heat is reversed, as when this same steam condenses at atmospheric pressure, 970.4 Btu will flow out as each pound of dry saturated steam at 212 F is reconverted to a pound of liquid at 212 F.

Next add 180.0 and 970.4 to give 1150.4 Btu, the total heat that must be supplied to convert one pound of water at 32 F into dry saturated steam. The table lists this figure as the *enthalpy of the saturated vapor.*

If, now, the steam is taken away from the presence of the boiling water and is then heated in a superheater, its temperature will rise above the saturation temperature, and its enthalpy will increase by the amount of heat supplied per pound. Total enthalpy of superheated steam is given in Table 3.

HELPFUL HINTS

THROTTLING. When steam expands without doing mechanical work, *its enthalpy does not change.* This type of expansion is called throttling, and occurs whenever flowing steam encounters fixed resistances such as orifices, throttling valves, pipe friction or cramped fittings. Examples of how to figure what happens when steam is throttled are shown on the next two pages, along with examples of how to use the following practical hints.

HEATING OR COOLING WATER. Amount of heat supplied or removed to heat or cool one pound of water is simply the change in enthalpy. For all cases within range of everyday operation in low- and medium-pressure steam plants take enthalpy change in the water as equal to the temperature change.

STEAM GENERATION, CONDENSATION. Heat supplied by a steam generator to convert feedwater into steam is merely the enthalpy of the final steam minus the enthalpy of the feedwater.

Heat removed from a pound of exhaust steam by a condenser is the enthalpy of the exhaust steam minus the enthalpy of water entering the hot well. Note, however, that the exhaust steam is almost always wet, so its enthalpy cannot be taken directly from the table.

The enthalpy of wet steam is the enthalpy of the liquid *plus* the dryness percent multiplied by the enthalpy of the evaporation. It can also be figured as the enthalpy of the saturated vapor *minus* the percent moisture multiplied by the enthalpy of evaporation.

EFFICIENCY. The thermal efficiency of any device is its output divided by its input. In the case of a steam generator the output is the heat required to convert the feedwater into the delivered steam. The input is the heat in the fuel.

1—SAT PRESSURES

Abs press Psi	Temp F	Specific vol Sat liquid	Specific vol Sat vapor	Enthalpy ("Heat") Sat liquid	Enthalpy ("Heat") Evap	Enthalpy ("Heat") Sat vapor
0.50	79.58	0.01608	641.4	47.6	1048.8	1096.4
1.0	101.74	0.01614	333.6	69.7	1036.3	1106.0
2.0	126.08	0.01623	173.73	94.0	1022.2	1116.2
3.0	141.48	0.01630	118.71	109.4	1013.2	1122.6
4.0	152.97	0.01636	90.63	120.9	1006.4	1127.3
5.0	162.24	0.01640	73.52	130.1	1001.0	1131.1
6.0	170.06	0.01645	61.98	138.0	996.2	1134.2
7.0	176.85	0.01649	53.64	144.8	992.1	1136.9
8.0	182.86	0.01653	47.34	150.8	988.5	1139.3
9.0	188.28	0.01656	42.40	156.2	985.2	1141.4
10	193.21	0.01659	38.42	161.2	982.1	1143.3
14.7	212.00	0.01672	26.80	180.0	970.4	1150.4
15	213.03	0.01672	26.29	181.1	969.7	1150.8
20	227.96	0.01683	20.089	196.2	960.1	1156.3
25	240.07	0.01692	16.303	208.5	952.1	1160.6
30	250.33	0.01701	13.746	218.8	945.3	1164.1
40	267.25	0.01715	10.498	236.0	933.7	1169.7
50	281.01	0.01727	8.515	250.1	924.0	1174.1
60	292.71	0.01738	7.175	262.1	915.5	1177.6
70	302.92	0.01748	6.206	272.6	907.9	1180.6
80	312.03	0.01757	5.472	282.0	901.1	1183.1
90	320.27	0.01766	4.896	290.6	894.7	1185.3
100	327.81	0.01774	4.432	298.4	888.8	1187.2
110	334.77	0.01782	4.049	305.7	883.2	1188.9
120	341.25	0.01789	3.728	312.4	877.9	1190.4
130	347.32	0.01796	3.455	318.8	872.9	1191.7
140	353.02	0.01802	3.220	324.8	868.2	1193.0
150	358.42	0.01809	3.015	330.5	863.6	1194.1
160	363.53	0.01815	2.834	335.9	859.2	1195.1
170	368.41	0.01822	2.675	341.1	854.9	1196.0
180	373.06	0.01827	2.532	346.1	850.8	1196.9
190	377.51	0.01833	2.404	350.8	846.8	1197.6
200	381.79	0.01839	2.288	355.4	843.0	1198.4
250	400.95	0.01865	1.8438	376.0	825.1	1201.1
300	417.33	0.01890	1.5433	393.8	809.0	1202.8
350	431.72	0.01913	1.3260	409.7	794.2	1203.9
400	444.59	0.0193	1.1613	424.0	780.5	1204.5
450	456.28	0.0195	1.0320	437.2	767.4	1204.6
500	467.01	0.0197	0.9278	449.4	755.0	1204.4
600	486.21	0.0201	0.7698	471.6	731.6	1203.2
700	503.10	0.0205	0.6554	491.5	709.7	1201.2
800	518.23	0.0209	0.5687	509.7	688.9	1198.6
900	531.98	0.0212	0.5006	526.6	668.8	1195.4
1000	544.61	0.0216	0.4456	524.4	649.4	1191.8
1200	567.22	0.0223	0.3619	571.7	611.7	1183.4
1500	596.23	0.0235	0.2765	611.6	556.3	1167.9

2—SAT TEMPERATURES

Temp F	Abs press Psi	Specific vol Sat liquid	Specific vol Sat vapor	Enthalpy ("Heat") Sat liquid	Enthalpy ("Heat") Evap	Enthalpy ("Heat") Sat vapor
32	0.08854	0.01602	3306	0.00	1075.8	1075.8
35	0.09995	0.01602	2947	3.02	1074.1	1077.1
40	0.12170	0.01602	2444	8.05	1071.3	1079.3
45	0.14752	0.01602	2036.4	13.06	1068.4	1081.5
50	0.17811	0.01603	1703.2	18.07	1065.6	1083.7
55	0.2141	0.01603	1430.7	23.07	1062.7	1085.8
60	0.2563	0.01604	1206.7	28.06	1059.9	1088.0
65	0.3056	0.01605	1021.4	33.05	1057.1	1090.2
70	0.3631	0.01606	867.9	38.04	1054.3	1092.3
75	0.4298	0.01607	740.0	43.03	1051.5	1094.5
80	0.5069	0.01608	633.1	48.02	1048.6	1096.6
85	0.5959	0.01609	543.5	53.00	1045.8	1098.8
90	0.6982	0.01610	468.0	57.99	1042.9	1100.9
95	0.8153	0.01612	404.3	62.98	1040.1	1103.1
100	0.9492	0.01613	350.4	67.97	1037.2	1105.2
105	1.1016	0.01615	304.5	72.95	1034.3	1107.3
110	1.2748	0.01617	265.4	77.94	1031.6	1109.5
115	1.4709	0.01618	231.9	82.93	1028.7	1111.6
120	1.6924	0.01620	203.27	87.92	1025.8	1113.7
125	1.9420	0.01622	178.61	92.91	1022.9	1115.8
130	2.2225	0.01625	157.34	97.90	1020.0	1117.9
135	2.5370	0.01627	138.95	102.9	1017.0	1119.9
140	2.8886	0.01629	123.01	107.9	1014.1	1122.0
145	3.281	0.01632	109.15	112.9	1011.2	1124.1
150	3.718	0.01634	97.07	117.9	1008.2	1126.1
155	4.203	0.01637	86.52	122.9	1005.2	1128.1
160	4.741	0.01639	77.29	127.9	1002.3	1130.2
165	5.335	0.01642	69.19	132.9	999.3	1132.2
170	5.992	0.01645	62.06	137.9	996.3	1134.2
175	6.715	0.01648	55.78	142.9	993.3	1136.2
180	7.510	0.01651	50.23	147.9	990.2	1138.1
185	8.383	0.01654	45.31	152.9	987.2	1140.1
190	9.339	0.01657	40.96	157.9	984.1	1142.0
200	11.526	0.01663	33.64	168.0	977.9	1145.9
210	14.123	0.01670	27.82	178.1	971.6	1149.7
212	14.696	0.01672	26.80	180.0	970.4	1150.4
220	17.186	0.01677	23.15	188.1	965.2	1153.4
240	24.969	0.01692	16.323	208.3	952.2	1160.5
260	35.429	0.01709	11.763	228.6	938.7	1167.3
280	49.203	0.01726	8.645	249.1	924.7	1173.8
300	67.013	0.01745	6.466	269.6	910.1	1179.7
350	134.63	0.01799	3.342	321.6	870.7	1192.3
400	247.31	0.01864	1.8633	375.0	826.0	1201.0
450	422.6	0.0194	1.0993	430.1	774.5	1204.6
500	680.8	0.0204	0.6749	487.8	713.9	1201.7
550	1045.2	0.0218	0.4240	549.3	640.8	1190.0

TYPICAL STEAM PROBLEMS

Run through the following examples if any statements on the preceding page are not entirely clear.

HEATING WATER. *How much heat is required to warm 3200 lb of water from 70 F to 180 F?*

Difference in enthalpies (Table 2 = 147.9 − 38.0 = 109.9 Btu. Or just take the difference in temperatures = 110 Btu. Then 110 x 3200 = 352,000 Btu = total heat required.

FUEL TO HEAT WATER. *Suppose foregoing heater is fired, with an efficiency of 60 per cent, by city gas of 500 Btu. How much gas is consumed?*

Divide 352,000 by 0.60 to get gas-heat requirements of 587,000 Btu. Then 587,000 ÷ 500 = 1174 cu ft of gas.

STEAM RADIATOR. *Dry saturated steam enters a unit heater at 20 psi abs. Condensate is cooled to 190 F before entering trap. If heater condenses 300 lb of steam per hour how much heat is supplied to the space?*

Enthalpy loss is 1156.3 − 157.9 = 998.4. Heat supplied to space is 998 x 300 = 299,000 Btu per hr.

STEAM GENERATION. *How much heat is needed to convert one pound of feedwater at 200 F into dry saturated steam at 135 psi gage (150 psi abs)?*

Here difference in enthalpy is 1194.1 − 168.0 = 1026 Btu.

In the foregoing what heat would be needed if the steam were 98 per cent dry (or 2 per cent wet)?

Enthalpy of the wet steam = 1194.1 − 0.02 x 863.6 = 1194.1 − 17.3 = 1176.8 Btu. Here heat supplied is 1176.8 − 168.0 = 1008.8.

How much heat would be needed to convert one pound of feedwater at 300 F into superheated steam at 800 psi abs and 900 F?

Difference of enthalpies is 1455.4 − 269.6 = 1185.8, say 1185 Btu.

In this last case what is boiler efficiency if coal burned has 13,600 Btu per pound and evaporation per pound of coal is 9.4 lb of water?

Heat output per pound of fuel is 9.4 x 1185 = 11,140 Btu. Efficiency-output ÷ input = 11,140 ÷ 13,600 = 0.820 = 82.0%.

HEAT EXCHANGER. *A counter-flow heat exchanger with negligible radiation losses uses waste dirty hot water to warm clean service water. Waste water is cooled from 200 F to 100 F. Clean water is warmed from 60 F to 110 F. How many pounds of service water will be warmed by every pound of waste water?*

Without referring to steam tables, each pound of waste water gives up 200 − 100 = 100 Btu, and each pound of service water receives 110-60 = 50 Btu. The ratio is 2 lb of service water per pound of waste water.

WATER HEATED WITH STEAM COIL. *A hot water heater, operated by steam coil with thermostatic control, receives city water at 60 F and heats it to 130 F. Steam to coils is dry saturated at 5 psi gage (20 psi abs). Condensate is*

3 — SUPERHEATED STEAM

Abs Pressure Psi (Sat temp)		Sat liquid	Sat vapor	Temperature, degrees F 300	400	500	600	700	800	900	1000	1200
15	v	0.02	26.29	29.91	33.97	37.99	41.99	45.98	49.97	53.95	57.93	65.89
(213.03)	h	181.1	1150.8	1192.8	1239.9	1287.1	1334.8	1383.1	1432.3	1482.3	1533.1	1637.5
20	v	0.02	20.09	22.36	25.43	28.46	31.47	34.47	37.46	40.45	43.44	49.41
(227.96)	h	196.2	1156.3	1191.6	1239.2	1286.6	1334.4	1382.9	1432.1	1482.1	1533.0	1637.4
40	v	0.017	10.498	11.040	12.628	14.168	15.688	17.198	18.702	20.20	21.70	24.69
(267.25)	h	236.0	1169.7	1186.8	1236.5	1284.8	1333.1	1381.9	1431.3	1481.4	1532.4	1637.0
60	v	0.017	7.175	7.259	8.357	9.403	10.427	11.441	12.449	13.452	14.454	16.451
(292.71)	h	262.1	1177.6	1181.6	1233.6	1283.0	1331.8	1380.9	1430.5	1480.8	1531.9	1636.6
80	v	0.018	5.472	.....	6.220	7.020	7.797	8.562	9.322	10.077	10.830	12.332
(312.03)	h	282.0	1183.1	.....	1230.7	1281.1	1330.5	1379.9	1429.7	1480.1	1531.3	1636.2
100	v	0.018	4.432	.....	4.937	5.589	6.218	6.835	7.446	8.052	8.656	9.860
(327.81)	h	298.4	1187.2	.....	1227.6	1279.1	1329.1	1378.9	1428.9	1479.5	1530.8	1635.7
150	v	0.018	3.015	.....	3.223	3.681	4.113	4.532	4.944	5.352	5.758	6.564
(358.42)	h	330.5	1194.1	.....	1219.4	1274.1	1325.7	1376.3	1426.9	1477.8	1529.4	1634.7
200	v	0.018	2.288	.....	2.361	2.726	3.060	3.380	3.693	4.002	4.309	4.917
(381.79)	h	355.4	1198.4	.....	1210.3	1268.9	1322.1	1373.6	1424.8	1476.2	1528.0	1633.7
250	v	0.0187	1.8438	.....	.....	2.151	2.427	2.688	2.942	3.192	3.439	3.928
(400.95)	h	376.0	1201.1	.....	.....	1263.4	1318.5	1371.0	1422.7	1474.5	1526.6	1632.7
300	v	0.0189	1.5433	.....	.....	1.7675	2.005	2.227	2.442	2.652	2.859	3.269
(417.33)	h	393.8	1202.8	.....	.....	1257.6	1314.7	1368.3	1420.6	1472.8	1525.2	1631.7
400	v	0.0193	1.1613	.....	.....	1.2851	1.4770	1.6508	1.8161	1.9767	2.134	2.445
(444.59)	h	424.0	1204.5	.....	.....	1245.1	1306.9	1362.7	1416.4	1469.4	1522.4	1629.6
500	v	0.0197	0.9278	.....	.....	0.9227	1.1591	1.3044	1.4405	1.5715	1.6996	1.9504
(467.01)	h	449.4	1204.4	.....	.....	1231.3	1298.6	1357.0	1412.1	1466.0	1519.6	1627.6
600	v	0.0201	0.7698	.....	.....	0.7947	0.9463	1.0732	1.1899	1.3013	1.4096	1.6208
(486.21)	h	471.6	1203.2	.....	.....	1215.7	1289.9	1351.1	1407.7	1462.5	1516.7	1625.5
800	v	0.0209	0.5687	.....	.....	.....	0.6779	0.7833	0.8763	0.9633	1.0470	1.2088
(518.23)	h	509.7	1198.6	.....	.....	.....	1270.7	1338.6	1398.6	1455.4	1511.0	1621.4
1000	v	0.0216	0.4456	.....	.....	.....	0.5140	0.6084	0.6878	0.7604	0.8294	0.9615
(544.61)	h	542.4	1191.8	.....	.....	.....	1248.8	1325.3	1389.2	1448.2	1505.1	1617.3
1500	v	0.0235	0.2765	.....	.....	.....	0.2815	0.3719	0.4352	0.4893	0.5390	0.6318
(596.23)	h	611.6	1167.9	.....	.....	/....	1174.5	1287.2	1363.8	1429.3	1490.1	1606.8
2000	v	0.0257	0.1878	.....	.....	.....	.....	0.2489	0.3074	0.3532	0.3935	0.4668
(636.82)	h	671.7	1135.1	.....	.....	.....	.....	1240.0	1335.5	1409.2	1474.5	1596.1
2500	v	0.0287	0.1307	.....	.....	.....	.....	0.1686	0.2294	0.2710	0.3061	0.3678
(668.13)	h	730.6	1091.1	.....	.....	.....	.....	1176.8	1303.6	1387.8	1458.4	1585.3
3000	v	0.0346	0.0858	.....	.....	.....	.....	0.0984	0.1760	0.2159	0.2476	0.3018
(695.36)	h	802.5	1020.3	.....	.....	.....	.....	1060.7	1267.2	1365.0	1441.8	1574.3
3206.2	v	0.0503	0.0503	.....	.....	.....	.....	.....	0.1583	0.1981	0.2288	0.2806
(705.40)	h	902.7	902.7	.....	.....	.....	.....	.....	1250.5	1355.2	1434.7	1569.8

trapped from coil at 140 F. How much steam will be consumed in heating 8500 lb water, assuming that heater is well lagged and radiation losses negligible?

Heat received per pound water is 130 − 60 = 70 Btu. Heat delivered per pound of condensing steam is 1156.3 − 107.9 = 1048 Btu. Then every pound of steam will heat 1048 ÷ 70 = 14.97 lb water. Total steam required will be 8500 ÷ 14.97 = 568 lb.

THROTTLING. *Dry saturated steam at 130 psi abs is reduced to 20 psi abs by a throttling valve. What will be the final condition?*

Original enthalpy is 1191.7 Btu. Throttling does not change enthalpy, so we must use the tables to find what kind of steam at 20 psi abs has this same enthalpy. Looking first in Table 1 we see that the enthalpy of dry saturated steam at 20 psi abs is only 1156.3 Btu, so the throttled steam must be superheated. Looking along the 20-psi line in Table 3 we see that the steam temperature must be 300 F, to give the required enthalpy.

Amount of superheat is 300 F − 228 F = 72 deg. Here 228 F is the saturation temperature, obtained from Table 3 or Table 1.

In this case we picked data that would bring the answer to an even 300 F. This illustrates the method. For practical work you need the actual Keenan and Keyes tables which give steam properties for 10-deg steps at the 20 psi pressure. The complete table also includes a so-called Mollier chart, convenient for solving throttling problems and others involving steam expansion.

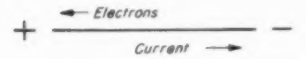
THROTTLING IN PIPE. *Steam passing through a long insulated outdoor pipe line may suffer a substantial heat loss from the line, as well as a reduction of pressure by throttling (here pipe friction). Suppose the steam starts dry saturated at 180 psi abs. Pressure at delivery end is down to 150 psi abs, say. Heat loss through insulation figures as 30 Btu per pound of steam. What will be the final quality of the steam?*

Initial enthalpy is 1196.9. Final enthalpy is 30 Btu less or 1166.9 Btu. Looking along the 150 psi line in Table 3, we see that 1166.9 is less than the saturation enthalpy of 1194.1 Btu, so we turn to Table I for help. Actual enthalpy of steam at end of line falls below the saturation enthalpy by 1194.1 − 1166.9 = 27.2 Btu.

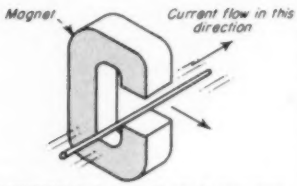
Table lists enthalpy of evaporation as 863.6 Btu. Therefore fraction of unevaporated water in delivered wet steam is 27.2 ÷ 863.6 = 0.0314 or 3.1%. Therefore the quality of steam at end of line will be 96.9%, assuming that all this condensation remains suspended in the steam. If any of this liquid settles in the trap and is trapped off, the dryness of the delivered steam will be correspondingly increased.

BASIC ELECTRICITY

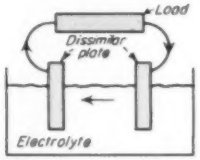
WHAT ELECTRICITY IS



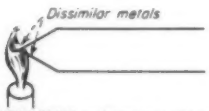
CURRENT FLOW is normally measured from (+) to (−); electrons go reverse



MAGNETISM induces voltage in any conductor kept moving within magnetic field



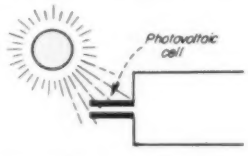
ELECTROLYTIC current flows when two dissimilar metals are put in an electrolyte



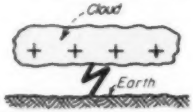
THERMOELECTRIC voltage is generated by heating dissimilar metals at junction

Smallest particle a chemical *element* can exist as, and still keep its physical and chemical characteristics, is an *atom*. Each atom has a *nucleus* at center made up of *protons* and *neutrons*. *Electrons* move around nucleus.

Protons carry positive (+) charges and electrons carry negative (−) charges. *Electricity* is present when electrons are kept away from protons. They will always try to get together . . . the electrons moving toward the protons. When electrons find a path to move along, *current* is flowing. Materials through which current flows easily (electrons are easily separated from protons) are called *conductors*. Materials through which current does *not* flow easily (protons hold electrons tightly) are *non-conductors* or *insulators*.

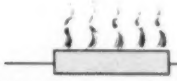


PHOTOVOLTAIC cell (lightmeter) causes slight voltage when exposed to light



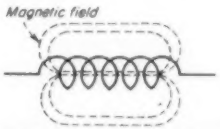
STATIC electricity is charge built up on clouds, moving belts: flash discharge

CIRCUIT COMPONENTS

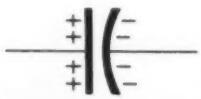


RESISTANCE, like friction, is always present. Long wires have more resistance than short ones; big wires have less resistance than small ones. Copper, highly conductive, is most commonly used wire

All circuits contain resistance, inductance, capacitance either as separate elements or distributed throughout. Resistors give off energy as heat; inductors store it in their magnetic fields; capacitors store energy on their plates. *Electronic* tubes act like valves to control flow of current in electronic circuits.



INDUCTANCE stems from shaping wire into a coil. Resulting magnetic fields will join forces and induce a counter voltage in coil as a whole. Induced voltage will be in opposition to that impressed on coil



CAPACITANCE depends on presence of two plates separated by insulator called *dielectric*. Energy can be stored on plates as electric charge. If well-insulated, charge takes several hours to leak off

ELECTRICAL UNITS

Since electricity hinges on the presence and flow of electrons, let's define units in terms of electrons:

COULOMB (Q) is basic quantity of electricity (electrical charge). One coulomb equals 6.25 billion billion electrons.

AMPERE (I) is the unit of current. One ampere current means that one coulomb flows past a point in a circuit every second.

VOLT (V or E) is the unit of pressure that pushes current through a circuit. One volt will push one ampere through a resistance of one *ohm*.

OHM (R) is unit of resistance to current flow. One ohm is quantity of resistance producing a potential drop of 1 volt when the current in it is 1 ampere. The ohm (X_c or X_l) is also the unit for *reactance* of condensers and inductors. The *mho* is the unit of *conductance* (the reciprocal of resistance: mho = 1/ohm). A conductance of 1 mho will pass a current of 1 amp when subjected to 1 volt.

WATT (W) measures power in a circuit. Watts equal current squared times resistance (I^2R). One watt is the power used for 1 ampere to flow through 1 ohm.

WATTHOUR measures energy or work done in a circuit. Simply multiply watts by time in hours that power is flowing.

FARAD (C) is the unit of capacitance. A condenser has a capacitance of one farad when a charge of one coulomb produces a potential difference of one volt. Condensers are rated *microfarads* (millionths of farads).

HENRY (L) is unit of inductance. A circuit has inductance of 1 henry if a current *change* of 1 ampere per sec causes one volt to be induced in it.

MICRO used before volt, amp, etc means one millionth. Thus 1 microamp means 0.000001 ampere.

MILLI means one thousandth (0.001) of a volt, amp, etc.

KILO means a thousand. Hence 1 kilowatt equals 1000 watts.

MEG indicates a million. One megohm means 1,000,000 ohms. (Note: On circuit diagrams, for ohms only, 1 Meg stands for 1,000,000 ohms but 1 M stands for 1000 ohms.)

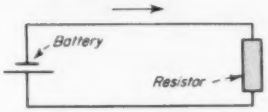
DIRECT-CURRENT CIRCUITS

OHM'S LAW. Unlike ac, dc current keeps flowing in one direction. This simplifies figuring, since capacitance and inductance can be neglected. Ohm's law states: Current in any dc circuit equals the voltage across circuit divided by circuit resistance, or $I = E \div R$, where I is amps, E is volts, R is ohms.

Above equation can be juggled to find either the voltage or resistance:

$$E = I \times R \text{ or } R = E \div I$$

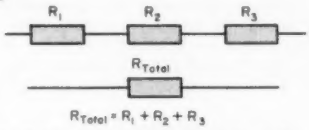
DC POWER taken by a circuit is product of voltage across circuit times current flowing through it: $W = E \times I$, where W is watts, E volts and I amps. Likewise $W = I^2 \times R$ or $W = E^2 \div R$. Thus 3 amps through 2 ohms ($3 \times 3 \times 2$) = 18 watts of power.



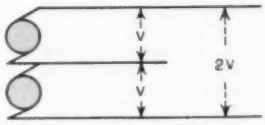
In simple series circuit there is only one path for the current. It threads its way through resistor and back to battery

SERIES-PARALLEL CIRCUITS

Simplest electrical circuit is series setup where all circuit components are in single line with same current through each. Total resistance is sum of separate resistances. Voltage across each is proportional to its resistance. For 2 ohms, 3 ohms and 5 ohms in series, sum equals 10 ohms. Voltage drops are 20, 30 and 50% of total voltage.



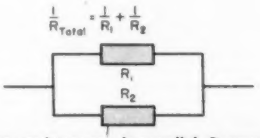
To find total value of resistors in series add them up. Use this value, R_t, to find $I = V \div R_t$ or voltage from the current



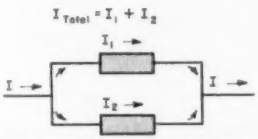
Power supply is generally 3-wire source. Here generators are in series with mid-tap taken for *neutral*. Note voltage relations

PARALLEL CIRCUITS

Each parallel leg receives full circuit voltage, but total current splits up through each *inversely* as its resistance. Total resistance is reciprocal of sum of reciprocals of separate resistances. For 2, 3 and 5 ohms in parallel, first $1/2+1/3+1/5=31/30$. Total resistance = $30/31$ = 0.97 ohms. Currents are 1/2, 1/3 and 1/5 of total.



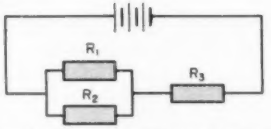
These resistors are in parallel. R_t equals resistance of one divided by number of resistors *when each has same resistance*



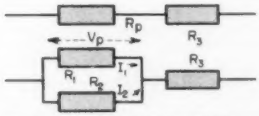
Voltage is same across all parallel resistors. To find each current divide voltage by each resistance. Then I is their sum

SERIES—PARALLEL CIRCUITS

Many industrial circuits combine resistors in parallel with those in series. To find total resistance of this combination, break it into two steps. First reduce each parallel group to a single equivalent series resistance. Then add up all series and equivalent series resistors. Find total current by Ohm's Law, then split into branches.



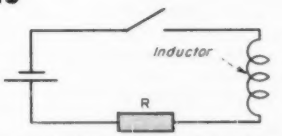
Steps for finding current in each resistor: (1) Reduce parallel group to equivalent resistor (2) Add to series resistor (3) I_t



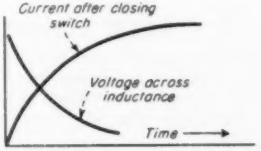
$= V \div R_t$ then (4) Find voltage across parallel group $V_p = I_t R_p$. (5) Currents are then: $I_1 = V_p \div R_1$ and $I_2 = V_p \div R_2$

INDUCTION IN DC CIRCUITS

When switch is closed on dc circuit with a coil, current increases as coil's magnetic field begins to build up because changing magnetic field's strength induces counter-voltage opposing applied voltage. As field builds up, counter-voltage decreases, current increases to constant value. This is self-induction or "flywheel" action.



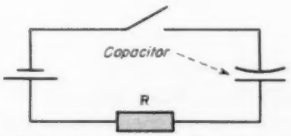
When switch is opened the magnetic field surrounding coil collapses. This induces high voltage, may puncture insulation



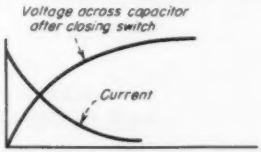
Consider power taken by inductor on closing switch as stored in magnetic field. Current builds up in seconds or less

CAPACITOR ACTION

Action is reverse with capacitor in circuit. When switch is first closed there is no charge on the plates, so there can be no voltage across condenser. Initial current is maximum, decreasing with time as charge builds up. Once charge has built up to capacity, condenser acts as a block to flow of dc current. Thus a capacitor acts like a spring.

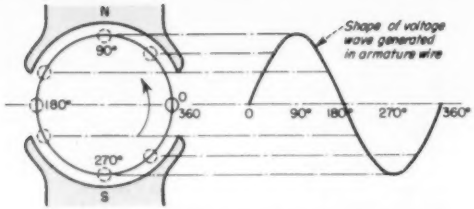


To find total value of capacitors in parallel or series: $C_{parallel} = C_1 + C_2 + C_3$; and $1/C_{series} = 1/C_1 + 1/C_2 + 1/C_3$



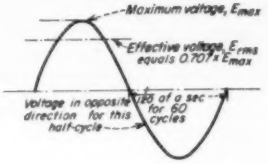
Capacitor will pass ac current, but not dc after steady state is reached. One use for condenser is to block dc in ac circuit

ALTERNATING-CURRENT CIRCUITS



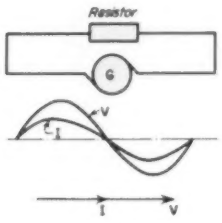
GENERATING AC SINE WAVE

Voltage induced in coil at any instant depends on its relative position to magnetic field. When coil is turning parallel to field (0 and 180 degrees) no voltage is induced. Likewise maximum voltage is generated when coil is passing perpendicular to field (90 and 270 degrees). Pattern of ac voltage is called *sine wave* because volts generated at any instant is maximum voltage times sine of angle coil makes with zero


Maximum voltage, E_{max}
Effective voltage E_{rms} equals 0.707 x E_{max}
Voltage in opposite direction for this half-cycle
1/120 of a sec for 60 cycles

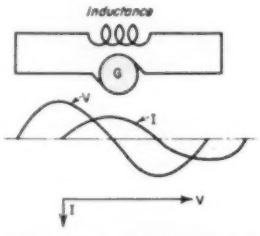
EFFECTIVE VOLTS, AMPS

Volts and amps measured by meters are effective volts and amps. They're called effective because 1 rms amp will generate the same amount of heat in a 1 ohm resistor as will 1 amp of dc current



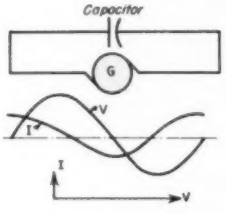
RESISTANCE ONLY

Current is right in step with voltage where the load is a pure resistance. This holds true for most lighting loads



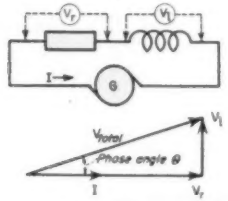
INDUCTIVE REACTANCE

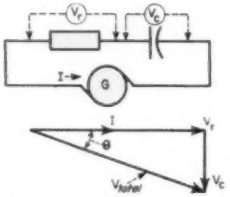
Inductive current lags voltage. Reactance X_l in ohms, opposing current flow is 6.28 × f × L. L is henries, f frequency



CAPACITIVE REACTANCE

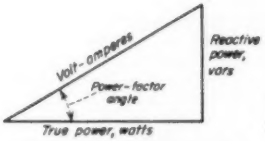
Capacitor current leads volts. Reactance X_c in ohms is 0.159 ÷ (f × C). C is farads, f is frequency, cycles per sec





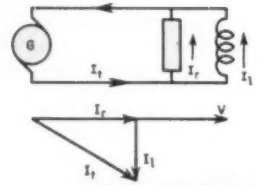
BASIC COMPONENTS IN SERIES

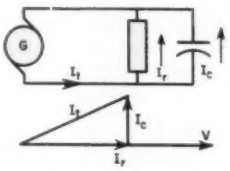
Current is the same throughout, but voltage drops across resistor and reactance will be out of step (phase) although their vector sum equals the impressed voltage. Note resultant current, *I*, lags behind V_l in inductive circuit and leads V_c in capacitive case. But voltage drop across resistor and current flowing through it are in step



POWER FACTOR

An ac electrical system carries two types of power: (1) true power, watts, that pulls the load (Note: Mechanical load reflects back into an ac system as resistance.) and (2) reactive power, vars, that generates magnetism within inductive equipment. The vector sum of these two will give actual volt-amperes flowing in the circuit (see above). Power factor is the cosine of the angle between true power and volt-amperes.





SAME COMPONENTS IN PARALLEL

Find current and its phase angle in each leg; then add vectors, as shown, to find total current. Resistance, inductive and capacitive reactances can be combined vectorially as one quantity, *impedance*, Z. ($Z = V \div I_t$). To find Z: Lay out R ohms horizontally, X_l ohms up 90 deg, X_c ohms down 90 deg. Z is resultant at the power-factor angle

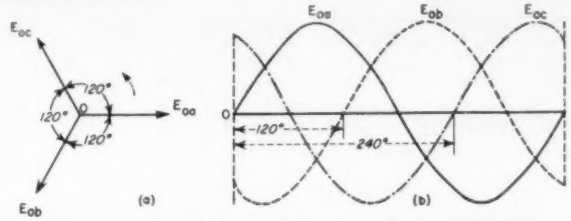
SINGLE-PHASE POWER

Power of a single-phase ac circuit equals voltage times current times power factor: $P_{watts} = E_{volts} \times I_{amps} \times pf$. To figure reactive power, vars squared equal volt-amperes squared *minus* power squared, or $vars = v\text{-}a\ (1\text{-}pf^2)$.

THREE-PHASE AC CIRCUITS

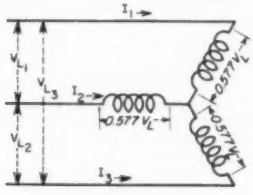
Three-phase is the most common polyphase system. It's a system having three distinct voltages out of step with one another. There are 120 deg between each voltage. In Fig. b note that at any instant the algebraic sum (measured up and down from centerline) of these three voltages is zero. When one voltage is zero, the other two are 86.6% maximum and have opposite signs.

The three phases are generated by placing each phase coil in the generator 120 deg apart, mechanically. Rotating dc field will then cut each phase coil in turn, inducing voltage in each out of step with the other two.



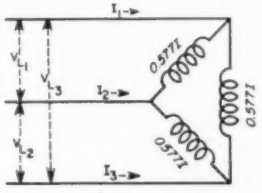
UTILIZATION OF THREE-PHASE POWER

Sine waves above are actually an oscillograph trace taken at any point in a three-phase system. (Each voltage or current wave actually comes from a separate wire but are shown for comparison on common base.) Big advantage of three phase comes in motor application when fed to stator winding. Having three separate stator windings (six poles) is like a three-cylinder instead of a one-cylinder (single-phase) motor



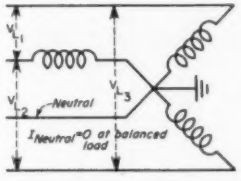
Y-CONNECTION

Consider the above three windings as primary of transformer. Current in all windings equals line current, but volts across windings = 0.577 × line volts



DELTA CONNECTION

Winding voltages equal line voltages, but currents split up so 0.577 I_{Line} flows through windings. Transformers operate at 58% capacity with one winding open



FOUR-WIRE SYSTEM

Most popular secondary distribution setup. V_1 is usually 208 v which feeds small power loads. Lighting loads at 120 v tap from any line to neutral

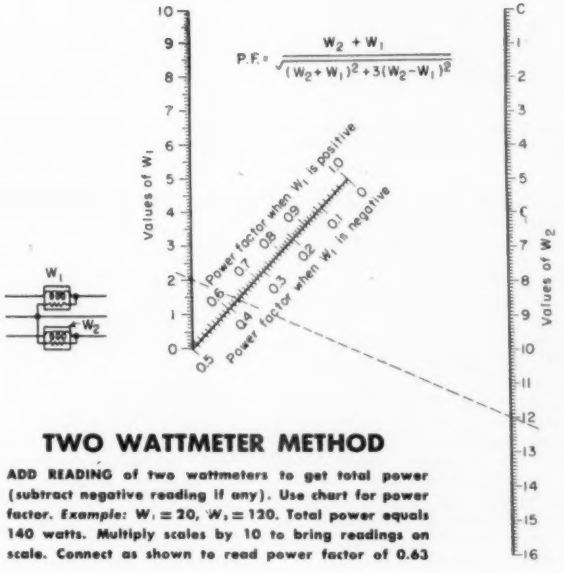
FIGURING THREE-PHASE POWER

Power in any balanced polyphase system (more than one phase) equals *line voltage* times *line current* times *power factor* times *the square root of the number of phases*. For three phase, $P_{TOTAL} = \sqrt{3}\ V_L \times I_L \times pf$ or $1.73\ V_L \times I_L \times pf$. Example: If balanced 3-phase load is 10 amp with line-to-line voltage of 208 v, pf 85%, power is $1.73 \times 208 \times 10 \times 0.85 = 3060$ watts.

Total volt-amperes is *line voltage* times *line current* times *square root of the number of phases*. For three phase, $v\text{-}a = \sqrt{3}\ V_L \times I_L$ or $1.73\ V_L \times I_L$, and *power factor* = *watts* ÷ $\sqrt{3}\ V_L I_L$ or $0.577 \times$ *watts* ÷ $(V_L I_L)$.

Power in any one phase is phase volts times phase current times power factor. Total power is the sum of all phase powers. For balanced three phase $P_{TOTAL} = 3 \times V_P \times I_P \times$ pf.

Power can be measured in any balanced or unbalanced polyphase system by using a number of single wattmeters (or elements on a single shaft) equal to *one less* than the number of *wires*. This means two wattmeters for three-phase three-wire and three for three phase four-wire.



TWO WATTMETER METHOD

ADD READING of two wattmeters to get total power (subtract negative reading if any). Use chart for power factor. *Example:* $W_1 = 20$, $W_2 = 120$. Total power equals 140 watts. Multiply scales by 10 to bring readings on scale. Connect as shown to read power factor of 0.63

PF CORRECTION

Improving (increasing) system power factor reduces reactive power (vars) and apparent power (volt-amperes) for same amount of true power (watts). Adding shunt capacitors to cancel effects of circuit inductance is one method.

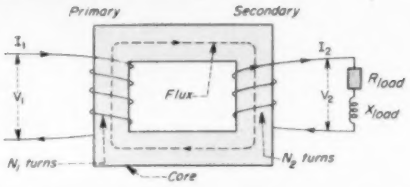
CAPACITOR CORRECTION FACTORS

(Kva of capacitors required = factor × kw load)

Existing Power Factor %	Corrected Power Factor 100%	95%	90%	85%	80%	75%
50	1.732	1.403	1.247	1.112	0.982	0.850
52	1.643	1.314	1.158	1.023	0.893	0.761
54	1.558	1.229	1.073	0.938	0.808	0.676
55	1.518	1.189	1.033	0.898	0.768	0.636
56	1.479	1.150	0.994	0.859	0.729	0.597
58	1.404	1.075	0.919	0.784	0.654	0.522
60	1.333	1.004	0.848	0.713	0.583	0.451
62	1.265	0.936	0.780	0.645	0.515	0.383
64	1.201	0.872	0.716	0.581	0.451	0.319
65	1.168	0.839	0.683	0.548	0.418	0.286
66	1.139	0.810	0.654	0.519	0.389	0.257
68	1.078	0.749	0.593	0.458	0.328	0.196
70	1.020	0.691	0.535	0.400	0.270	0.138
72	0.964	0.635	0.479	0.344	0.214	0.082
74	0.909	0.580	0.424	0.289	0.159	0.027
75	0.882	0.553	0.397	0.262	0.132	
76	0.855	0.526	0.370	0.235	0.105	
78	0.802	0.473	0.317	0.182	0.052	
80	0.750	0.421	0.265	0.130		
82	0.698	0.369	0.213	0.078		
84	0.646	0.317	0.161			
85	0.620	0.291	0.135			
86	0.594	0.265	0.109			
88	0.540	0.211	0.055			
90	0.485	0.156				
92	0.426	0.097				
94	0.363	0.034				
95	0.329					

EXAMPLE: Find capacitor kva to bring 500-kw load from 70 to 85% pf. Factor is 0.400, so 0.4 × 500 = 200 kva needed

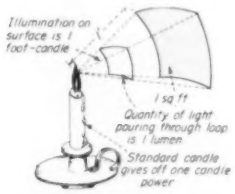
TRANSFORMERS



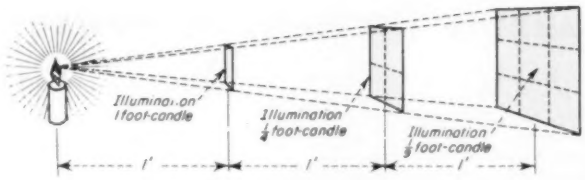
SIMPLE TRANSFORMER. Arrows shown are relative only, as directions reverse every half cycle with alternating current

Current in primary sets up magnetic field (flux) in core which in turn induces voltage across secondary. Secondary voltage V_2 is proportional to primary voltage V_1 in same ratio as number of turns N_2 is to N_1. Currents are inversely proportional as the turns ratio. So $V_1/V_2=N_1/N_2=I_2/I_1$. Impedance of secondary load and impedance of the secondary itself are both *reflected* back into the primary circuit as the square of the turns ratio. Impedance Z_t equals primary impedance plus reflected secondary impedance plus reflected load impedance. Or, $Z_t=Z_1+Z_2(N_1/N_2)^2+Z_{load}(N_1/N_2)^2$. Breaking this down into resistance and reactance: $R_t=R_1+R_2(N_1/N_2)^2+R_{load}(N_1/N_2)^2$ and $X_t=X_1+X_2(N_1/N_2)^2+X_{load}(N_1/N_2)^2$. All three can be calculated from current, voltage and power readings: $R_t=P\div I_1{}^2$ and $Z_t=V_1\div I_1$ so $X_t=\sqrt{Z_t{}^2-R_t{}^2}$. *Power factor* $=R_t\div Z_t$.

FUNDAMENTALS OF LIGHTING


Illumination on surface is 1 foot-candle
1 sq ft
Quantity of light pouring through loop is 1 lumen
Standard candle gives off one candle power

"OHM'S LAW" OF LIGHTING. Relationship of light quantity, intensity and density



INVERSE SQUARE LAW. Foot-candles of illumination vary inversely as square of the distance from light source. Doubling distance spreads lumens over four times area

Light is radiant energy (as are heat and radio waves) that's visible. Everything that we see is either a reflection of light or a direct source of light. Unit of light *intensity* is the *candlepower* (cp), fixed arbitrarily. Unit *quantity* of light is the *lumen*. One lumen is the amount of light falling on a 1-sq ft spherical section, all points of which are 1 ft away from a 1-cp source. A 1-cp source emits 12.57 lumens. Unit of light *density*, sometimes called *illumination*, is the *foot-candle* (ft-c). One ft-c equals 1 lumen per sq ft. Unit of *brightness* is the *foot-lambert*. Ft-l are the number of ft-c *reflected* from a surface. Reflection runs as high as 80% of input for white down to as low as 5% for black.

RECOMMENDED LIGHTING LEVELS

Lighted Area	Ft-c Needed
Locker Rooms	10
Machine Shops	
Rough bench	20
Automatic machines, medium buffing, etc.	30
Fine work	100
Extra Fine	200
Power plant	
Boilers, coal, ash handling, storage battery rooms	5
Ocb's, transformers, engines, generators, blowers, etc.	20
Control room, switchboards	30
Schools	
Class and study rooms	30
Drawing rooms	50
Laboratories	30-50
Lecture rooms	20-50
Elevators	10
Stairways and corridors	5
Welding	
General lighting	20
Supplementary lighting	1000
Office Areas and Drafting Rooms	
Bookkeeping and typing	50
Desk Work	30-50
Drafting	50
Hotels	
Corridors	5
Lobby	20
Dining rooms	5
Kitchen	20
Assembly work and inspection	
Medium-fine	50
Fine	100
Extra Fine	200

FIGURING WIRE, FUSE AND CONDUIT SIZES

Here are highlights *only* for figuring wire, conduit and fuse sizes according to procedures outlined in the National Electric Code.

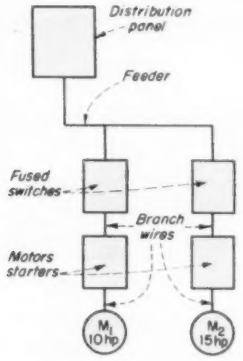
WIRE SIZES. Conductors supplying single motor should have current-carrying capacity not less than 125% motor full-load current rating. Conductors for two or more motors should have current capacity not less than 125% of largest full-load motor current plus sum of all other full-load motor currents.

CONDUIT SIZES. Table at right is based on wiring filling not more than 31% of inside conduit area for 2 conductors, 43% for three conductors, 40% for four or more conductors.

MOTOR FUSES. Find fuse size in table at right by multiplying factor times full-load current rating.

FEEDER FUSES. Fuse size should not be greater than largest motor's fuse rating plus sum of other full-load currents.

VOLT DROP. Use chart for checking volt drop. Code allows no more than 3% drop. Arrows compare three different type wires for same load current.



PROBLEM: Find sizes for feeder fuses, wires, conduits and branch fuses, wires, conduits. Motors are 3-ph, 220-v, full-voltage start, squirrel cage. RH wires

SOLUTION. Motor 1 pulls 27 amps full load, motor 2 takes 40 amps. Branch 1 wire has minimum capacity of 1.25×27=34 amps; so use No. 8 wire. Three No. 8 wires need ¾-in. conduit. Branch 2 wire capacity is 1.25×40=50; use No. 6 wire. Three No. 6 wires take 1-in. conduit. Feeder calls for 40+27+(0.25×40)=77; so use No. 4 wire, in 1¼-in. conduit. Motor fuse factors are both 3.0, so motor 1 needs 3×27=81, or an 85-amp fuse. Motor 2 needs 3×40=120, or a 125-amp fuse. Feeder fuse is 125+27=152, or 150-amp fuse.

WIRE DIMENSIONS AND CURRENT CAPACITIES

(From 1947 National Electric Code)

Wire size (AWG or Mcm)	Ohms (dc)* per 1000 ft (77 F)	Cross-sectional areas (sq in.) Types R, RH	Type TW	Type AVA	Allowable current capacity (amps at 86 F) Types R, TW	Type RH	Type AVA
14	2.575	.0230	.0135	.047	15	15	30
12	1.619	.0278	.0172	.055	20	20	35
10	1.018	.0460	.0224	.064	30	30	45
8	.641	.0760	.0408	.075	40	45	60
6	.410	.1238	.0819	.122	55	65	80
4	.259	.1605	.1087	.155	70	85	105
3	.205	.1817	.1263	.174	80	100	120
2	.162	.2067	.1473	.200	95	115	135
1	.129	.2715	.2027	.268	110	130	160
0	.102	.3107	.2367	.307	125	150	190
00	.0811	.3578	.2781	.353	145	175	215
000	.0642	.4151	.3288	.406	165	200	245
0000	.0509	.4840	.3904	.478	195	230	275
250 Mcm	.0431	.5917	.4877	.616	215	255	315
300 Mcm	.0360	.6837	.5581	.692	240	285	345
350 Mcm	.0308	.7620	.6291	.778	260	310	390
400 Mcm	.0270	.8365	.6969	.850	280	335	420
500 Mcm	.0216	.9834	.8316	.995	320	380	470

*Bare conductor

CONDUIT SIZES

(Inches, from NEC)

Wire size	Types R, RH, TW, AVA* 2 cond	3 cond	4 cond
14	½	½	½
12	½	½	¾
10	¾	¾	¾
8	¾	¾	1
6	1	1	1-¼
4	1-¼	1-¼	1-½
3	1-¼	1-¼	1-½
2	1-¼	1-¼	2
1	1-½	1-½	2
0	1-½	2	2
00	2	2	2-½
000	2	2	2-½
0000	2	2-½	3
250	2-½	2-½	3
300	2-½	2-½	3
350	3	3	3-½
400	3	3	3-½
500	3	3	3-½

* Conduit sizes for Type AVA hold only for wires No. 8 or larger

NOTE: For rewiring concealed conduit, two conductors can fill up to 40% of conduit inside area; three and four conductors can fill up to 50%. Use wire areas listed in top table for figuring maximum wire size.

MOTOR CURRENTS

(Amps at full load, from NEC)

Motor horsepower	3 phase* 220 volt	1 phase** 115 volt	Dc*** 230 volt
½	2	7.4	2.3
1	3.5	13	4.3
3	9	34	12
5	15	56	26
7½	22	80	29
10	27	100	38
15	40		56
25	64		92
50	125		180

* Add 6% for 208 v; divide by 2 for 440 v. ** Divide by 2 for 230 v. *** Multiply by 2 for 115 v.

MOTOR FUSES

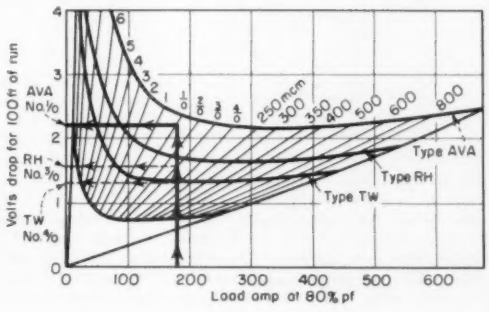
(From NEC)

Multiply full-load motor current by factor to determine maximum rating of fuse

Type motor	Factor	squirrel cage	
		Not over 30 amps	2.5
Single phase ac	3.0	Over 30 amps	2.0
Squirrel cage (full voltage, resistor reactor starting)	3.0	Wound rotor	1.5
		Direct current	1.5
Squirrel cage (auto-transformer start)		Code-lettered motors	
		Code letter A	1.5
Not over 30 amps	2.5	Code letter B-E*	2.5
Over 30 amps	2.0	Code letter F-R**	3.0
High-reactance		*Auto-trans start	2.0
		** " " "	2.5

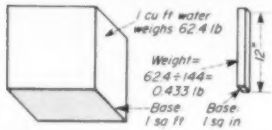
VOLT DROP BY CURRENT, WIRE SIZE, TYPE

Chart based on three single conductors in one conduit at 86 F. Enter with rated current, go straight up to wire size and type, then left to read volt drop. Curved heavy lines stand for maximum rating of labeled wire type.

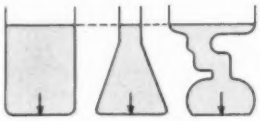


HYDRAULICS & PUMPING

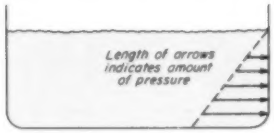
FACTS ABOUT FLUIDS



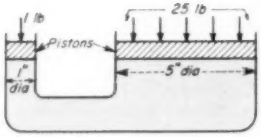
HEAD. One cu ft of water weighs 62.4 lb so a head of one ft is equal to 62.4 lb per sq ft. Dividing by 144 sq in., we get one ft head water equals 0.433 psi



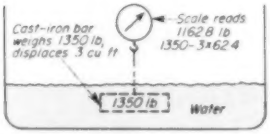
PRESSURE depends only on head or height of fluid above point at which pressure is measured. In sketches above, head is same for all even though shapes differ



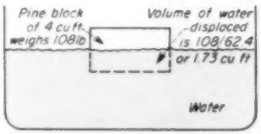
PRESSURE is same in all directions, so pressure acting on side of a container, or on a wall or dam, is proportional to the depth below surface of the fluid



HYDRAULIC PRESS. Small force on small piston produces a pressure transmitted without loss. Acting on large piston, this pressure produces a large force



ARCHIMEDES LAW: A body immersed in a fluid "loses" weight of fluid displaced. Iron bar above displaces 3 cu ft of water, which weighs 187.2 lb, so scale



reads 1350 – 187.2, or 1162.8 lb. Block of pine (4 cu ft) weighs 4 × 27 = 108 lb. Since it floats, weight of water displaced = 108 lb; volume is 108/62.4

Relatively simple laws governing fluids at rest have wide practical application. Sketches and captions at left summarize some of them. To these we should add definitions of *density* and *specific gravity*. Density is the mass of a substance per unit volume – usually expressed in lb per cu ft. Specific gravity is the density of a substance compared with that of another taken as a standard. Water is the common standard. On this basis, a specific gravity of 1 indicates a substance having the same density as water – 62.4 lb per cu ft. Specific gravities of less than one indicate materials lighter than water, hence materials that will float.

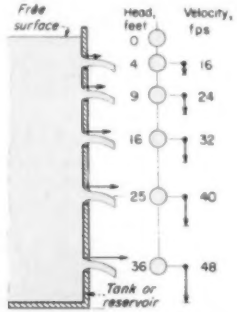
WATER CONVERSIONS

1 lb	= 0.0161 cu ft	= 0.120 gal
1 cu ft	= 7.48 gal	= 62.4 lb
1 gal	= 8.33 lb	= 0.134 cu ft
1 lb/hr	= .000004 cu ft/sec	= 0.002 gal/min
1 cu ft/sec	= 449 gal/min	= 250,000 lb/hr
1 gal/min	= 500 lb/hr	= 0.00223 cu ft/sec

GRAVITIES, DENSITIES

Material	Specific gravity	Density (av) lb per cu ft
Cast iron	7.2	450
Steel	7.8	487
Oak, white	0.77	48
Pine, white	0.43	27
Redwood	0.42	26
Earth, moist	1.3-1.6	87
Petroleum	0.87	54
Kerosene	0.79-0.82	50
Gasoline	0.70-0.75	45

WATER IN MOTION



JET VELOCITY follows same rule as that for a falling body. In sketch, head on each jet is same as total distance body has fallen. For both, velocity equals 8 × square root of head or distance. Jet velocity under 25-ft head is 40 fps ($8 \times \sqrt{25}$). This is same as velocity of a stone after falling same distance

Under steady flow conditions, the mass of fluid passing a point in a pipe in a given time is the same as that passing any other point. From this we see that the product of velocity and area must be the same at all points (*sketch, right*). Where area is large, velocity is small and vice versa.

ENERGY AND HEAD. Energy, as we've seen (pp 83), is the capacity to do work. A fluid may have such energy because of its elevation, its velocity, its pressure, or any combination of these. All three forms of energy may be reduced to equivalent head in feet, or in psi. Each form is convertible into either of the other two. Such changes constantly occur in piping systems.

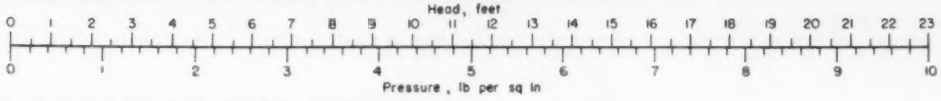
When a fluid flows through a perfectly smooth pipe, without friction, the sum of these three forms of energy, the *total head*, remains the same. This is true even though diameter of pipe and its elevation change.

BASIC LAW of steady flow states that the product of area and velocity must be the same at all points in a pipe

ELEVATION HEAD. At any point, a fluid in a pipe has potential energy because of its elevation above some arbitrarily chosen level or *datum*. In practical work, we deal with *differences* in elevation, so the datum we work from isn't important.

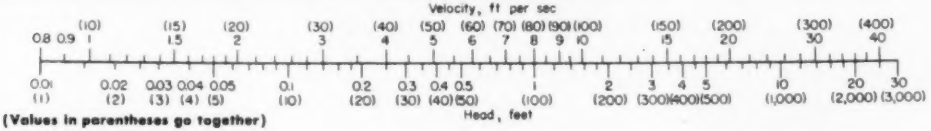
VELOCITY HEAD. A flowing fluid has energy of motion which is proportional to square of velocity. Doubling velocity multiplies head by four. Velocity head, feet, equals 0.0155 times square of velocity, ft per sec.

CONVERSION FROM HEAD IN FT OF WATER TO PSI



(For fluids other than water, multiply psi by specific gravity)

RELATION BETWEEN VELOCITY AND VELOCITY HEAD

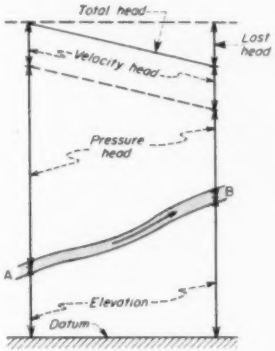


(Values in parentheses go together)

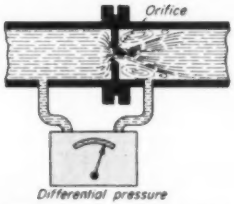
PRESSURE HEAD may be looked on as the force the fluid exerts against the walls of the pipe. It is the only part of the total head shown by a pressure gage. Pressure head, in feet, equals 0.433 times the pressure, in psi, divided by the specific gravity of the fluid.

PIPE FRICTION. Commercial pipes aren't smooth, so some of the fluid's energy is wasted in friction. Thus in flow from one point to another there is always a loss of head due to friction. We should, therefore, restate the general rule as follows: *When a fluid flows from one point to another, the sum of the elevation, velocity and pressure heads at the second point is equal to the total head at the first point, minus friction loss.*

SKETCH AT RIGHT illustrates this. Fluid flows in pipe of constant cross-section from point *A* to *B*. At *A* it has elevation head, pressure head and velocity head as indicated. Since section doesn't change, velocity is constant and there's no change in velocity head. Point *B* is higher than *A*, so elevation head increases. Pressure head at *B* is much less than at *A*, because part of it has been used in lifting the fluid from *A* to *B* and thus shows up as elevation head at *B*. Also, part of pressure head has been used in overcoming pipe friction. Difference in total head between *A* and *B* is head lost to friction.

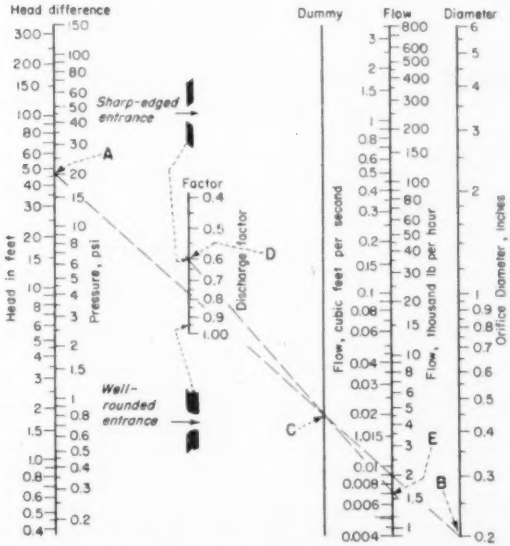


WATER-FLOW THROUGH ORIFICES



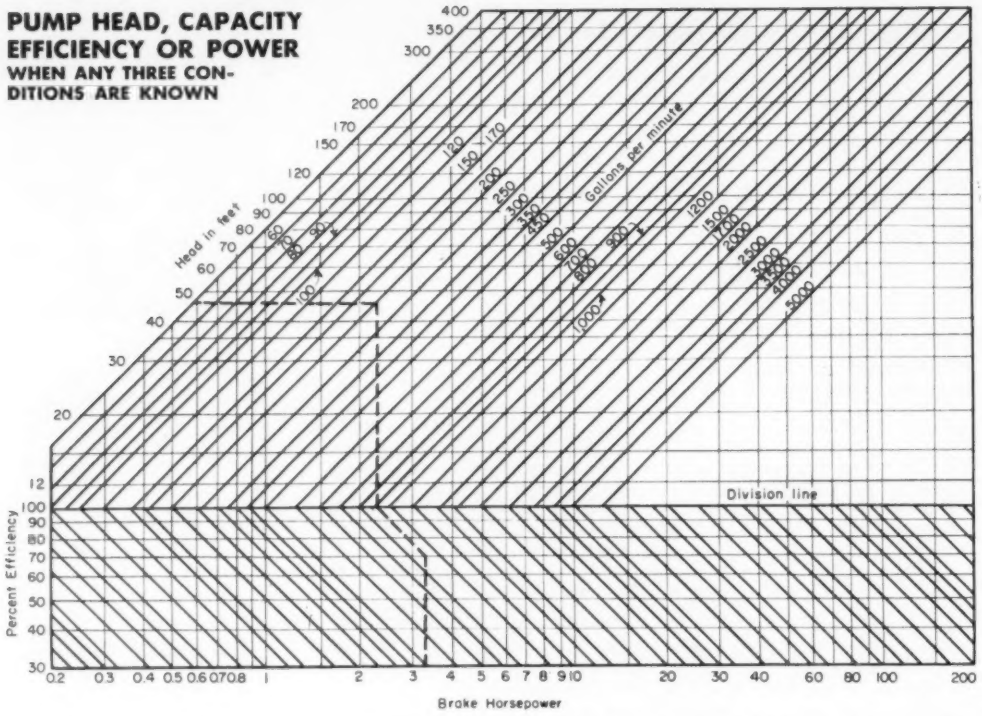
ORIFICES create a pressure drop. By measuring it we can calculate velocity and, if area is known, can find flow

Orifices measure flow by restricting it just enough to speed up velocity temporarily. Part of pressure head is changed to velocity head, so pressure *drops* across orifice. *Velocity* varies as 8 × *square root of head drop*, and *flow* equals *velocity* × *area*, so flow through orifice in cubic feet per second equals orifice area, sq ft × 8 × square root of head drop, ft × *orifice coefficient*. If coefficient is not known, it can be determined by collecting a measured volume in a measured time and working formula backward. (Chart is for water only; orifice diameter not over half pipe diameter.)



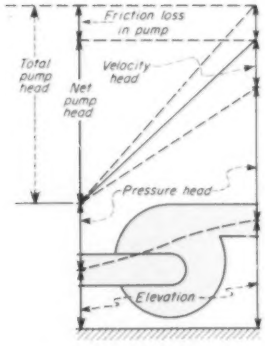
EXAMPLE: What is flow through 0.2-in. sharp-edged orifice if head difference across it is 20 psi? Draw line from *A* to *B*. Hold point *C* on dummy scale and draw line from *D* through *C* to *E*. Answer: Flow rate is 0.007 cfs, or 1600 lb per hr

PUMP HEAD, CAPACITY EFFICIENCY OR POWER WHEN ANY THREE CONDITIONS ARE KNOWN



DASHED LINE SHOWS SOLUTION for problem, page 104, "What hp does a 70% efficient pump develop delivering 200 gpm of water against a 45-ft head?" Enter chart at 45-ft head, go across to 200-gpm diagonal, straight down to *division line*, then along diagonal to efficiency and finally down to read 3¼ brake horsepower. Use same construction to find any unknown

PUMPS



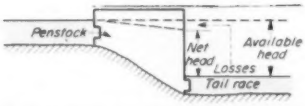
NET PUMP HEAD is total head at discharge (elevation plus pressure plus velocity) minus total head at suction (elevation plus pressure). Pressures at pump include effects of up and down stream elevations and friction losses.

A pump supplies *energy* for a fluid to do work against elevation, friction, etc. Supplying pressure is only part of the job. Work done is pounds of fluid moved against feet of head.

DETERMINING HEAD. Sketch at left shows what enters into pump head. Velocity head need be only figured once, at discharge, as all velocity head is supplied by pump except where pumps are in series. In many cases (see "Problem" page 104) velocity head is small enough to be ignored completely. And where difference in elevation between suction and discharge lines is slight, only pressure drop is important.

SUCTION LIFT. When pressure at suction is less than atmospheric and a vacuum gage is used, add amount of pressure below atmospheric to discharge pressure to determine pressure drop. Example: Head drop across a pump with 10-ft discharge head and 6-in. suction lift would be 10.5 ft.

WATER POWER



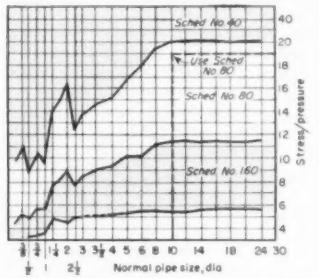
ACTUAL POWER INPUT to water turbine, in hp = *net head*, feet × *flow*, cfs ÷ 8.8

The input head to a water wheel or turbine is entirely elevation head, converted partly or wholly to velocity and pressure heads by the penstock feeding the turbine. Some of the available head is lost in the penstock.

The speed of a water turbine varies as 8 × square root of the net head. For comparing performance of different designs, turbine characteristics are reduced to unit speed, power and discharge constants for rpm, hp and cfs of a 1-in. wheel under a 1-ft head. Specific speed is rpm of wheel delivering 1 hp under 1-ft head.

DIMENSIONS OF COMMERCIAL STEEL AND IRON PIPE

Stress and flow data in this section should be used for preliminary estimates only. Use proper code for actual design. Note that schedules 40 and 80 are equivalent to *standard* and *extra strong* pipe in sizes through 8 in. Schedule 160 is only roughly equivalent to *double extra strong* pipe.



Divide allowable stress (from table below) by working pressure (gage). Enter graph with this figure. Dashed line shows solution for 10-in. pipe of *material 1* at 650 F, 500 psig. Stress from table divided by pressure is 9600 ÷ 500 = 19. Answer: Schedule 80.

ALLOWABLE STRESSES

(Psi, from Code)

Temp F	Piping materials 1*	2*	3*
	Power and Heating		
150	12,000	15,000	10,200
250	11,520	14,400	9,800
350	11,040	13,800	9,400
450	10,560	13,200	8,950
550	10,080	12,600	8,550
650	9,600	12,000	8,150
750	8,250	10,400	7,000
	Gas and Air		
100	18,000	21,000	15,300
450	15,650	18,250	13,300
	Oil (outside refinery limits)		
100**	25,500	29,750	21,700
	Refrigeration		
-	12,000	15,000	10,200

*1–Seamless carbon steel, ASTM A106, A53, API 5L, Grade A
*2–Seamless carbon steel, ASTM A106, A53, API 5L, Grade B
*3–Electric resistance-welded steel, ASTM A135, API 5L, Gra A
** 100 F and 100 psi

THERMAL EXPANSION

(Inches per 100 ft from 32 F)

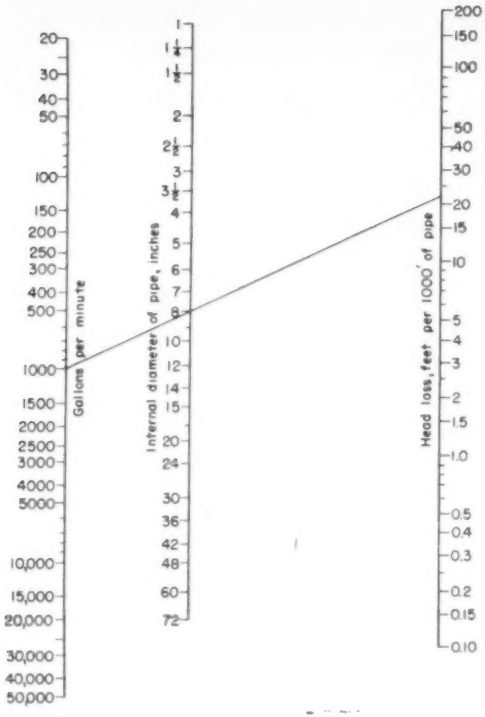
Temp F	Carbon Steel*	Cast Iron	Copper
-50	-0.6	-0.5	-1.1
0	-0.2	-0.2	-0.4
32	0	0	0
100	0.5	0.5	0.8
150	0.9	0.8	1.4
250	1.7	1.6	2.5
350	2.6	2.3	3.7
450	3.5	3.1	4.9
550	4.5		
650	5.5		
750	6.5		

* Also wrought iron and carbon molybdenum steel

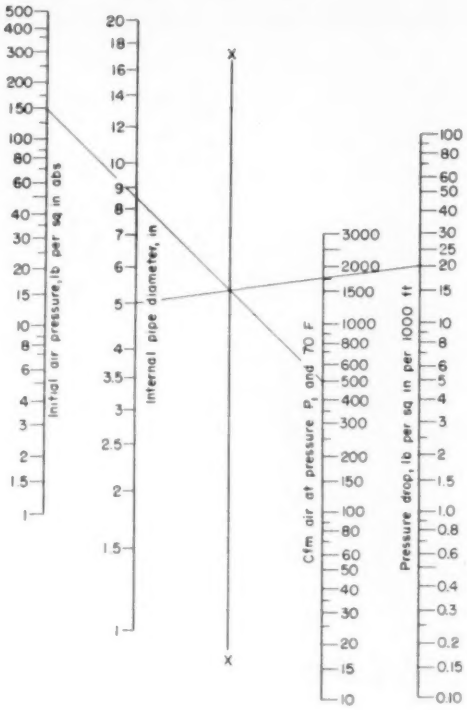
(From Data Book No. 211, copyright Tube Turns, Inc)

Nominal Pipe Size (Outside Dia)	Schedule No.	Inside Diameter, In.	Wall Thickness, In.	Weight of Pipe, Lb per Ft	Wt of Water, Lb per Ft Pipe	Outside Pipe Area, Sq Ft per Ft	Cross-section Inside Area, Sq In.	Cross-section Metal Area, Sq In.	Section Modulus
1/8 (.405)	40	.269	.068	.244	.0246	.106	.0568	.0720	.00530
	80	.215	.095	.314	.0157	.106	.0364	.0925	.00600
1/4 (.540)	40	.364	.088	.424	.0451	.141	.1041	.1250	.01230
	80	.302	.119	.535	.0310	.141	.0716	.1574	.01395
3/8 (.675)	40	.493	.091	.567	.0827	.177	.1910	.1670	.02160
	80	.423	.126	.738	.0609	.177	.1405	.2173	.02554
1/2 (.840)	40	.622	.109	.850	.1316	.220	.3040	.2503	.04070
	80	.546	.147	1.087	.1013	.220	.2340	.3200	.04780
	160	.466	.187	1.310	.0740	.220	.1706	.3836	.05269
3/4 1.050	40	.824	.113	1.130	.2301	.275	.5330	.3326	.07055
	80	.742	.154	1.473	.1875	.275	.4330	.4335	.08531
	160	.614	.218	1.940	.1280	.275	.2961	.5698	.10038
1 (1.315)	40	1.049	.133	1.678	.3740	.344	.8640	.4939	.1328
	80	.957	.179	2.171	.3112	.344	.7190	.6388	.1606
	160	.815	.250	2.850	.2261	.344	.5217	.8364	.1903
1¼ (1.660)	40	1.380	.140	2.272	.6471	.434	1.496	.6685	.2346
	80	1.278	.191	2.996	.5553	.434	1.283	.8815	.2913
	160	1.160	.250	3.764	.4575	.434	1.057	1.1070	.3421
1½ (1.900)	40	1.610	.145	2.717	.8820	.497	2.036	.800	.3262
	80	1.500	.200	3.631	.7648	.497	1.767	1.068	.4118
	160	1.337	.281	4.862	.6082	.497	1.405	1.430	.5080
2 (2.375)	40	2.067	.154	3.652	1.452	.622	3.355	1.075	.5606
	80	1.939	.218	5.022	1.279	.622	2.953	1.477	.7309
	160	1.689	.343	7.450	.767	.622	2.240	2.190	.979
2½ (2.875)	40	2.469	.203	5.79	2.072	.753	4.788	1.704	1.064
	80	2.323	.276	7.66	1.834	.753	4.238	2.254	1.339
	160	2.125	.375	10.01	1.535	.753	3.547	2.945	1.638
3 (3.500)	40	3.068	.216	7.57	3.20	.916	7.393	2.228	1.724
	80	2.900	.300	10.25	2.86	.916	6.605	3.016	2.225
	160	2.626	.437	14.30	2.35	.916	5.416	4.205	2.876
3½ (4.000)	40	3.548	.226	9.11	4.28	1.047	9.89	2.68	2.394
	80	3.364	.318	12.51	3.85	1.047	8.89	3.68	3.140
4 (4.500)	40	4.026	.237	10.79	5.51	1.178	12.73	3.17	3.214
	80	3.826	.337	14.98	4.98	1.178	11.50	4.41	4.271
	160	3.438	.531	22.60	4.02	1.178	9.28	6.62	5.900
5 (5.563)	40	5.047	.258	14.62	8.66	1.456	20.01	4.30	5.451
	80	4.813	.375	20.78	7.87	1.456	18.19	6.11	7.431
	160	4.313	.625	32.96	6.32	1.456	14.61	9.70	10.800
6 (6.625)	40	6.065	.280	18.97	12.51	1.735	28.89	5.58	8.50
	80	5.761	.432	28.57	11.29	1.735	26.07	8.40	12.22
	160	5.189	.718	45.30	9.16	1.735	21.15	13.36	17.81
8 (8.625)	40	7.981	.322	28.55	21.6	2.26	50.0	8.40	16.81
	80	7.625	.500	43.39	19.8	2.26	45.6	12.76	24.51
	160	6.813	.906	74.70	15.8	2.26	36.4	21.97	38.48
10 (10.750)	40	10.020	.365	40.48	34.1	2.81	78.9	11.91	29.90
	80	9.564	.593	64.40	31.1	2.81	71.8	18.91	45.56
	160	8.500	1.125	116.00	24.6	2.81	56.7	34.01	74.31
12 (12.750)	40	11.938	.406	53.6	48.5	3.34	111.9	15.74	47.1
	80	11.376	.687	88.6	44.0	3.34	101.6	26.03	74.6
	160	10.126	1.312	161.0	34.9	3.34	80.5	47.14	122.6
14 OD	40	13.125	.437	63	58.5	3.67	135.3	18.64	61.3
	80	12.500	.750	107	51.2	3.67	122.7	31.22	98.2
	160	11.188	1.406	190	42.6	3.67	98.3	55.63	159.6
16 OD	40	15.000	.500	83	76.5	4.20	176.7	24.35	91.5
	80	14.314	.843	137	69.7	4.20	160.9	40.14	144.6
	160	12.876	1.562	241	56.4	4.20	130.2	70.85	233.5
18 OD	40	16.874	.563	105	97.2	4.71	224.0	30.85	130.9
	80	16.126	.937	171	88.5	4.71	204.2	50.23	203.8
	160	14.500	1.750	304	71.5	4.71	165.1	89.34	331.5
20 OD	40	18.814	.593	123	120.4	5.24	278.0	36.15	170.4
	80	17.938	1.031	209	109.4	5.24	252.7	61.44	277.1
	160	16.126	1.937	374	88.5	5.24	204.2	109.92	453.6
24 OD	40	22.626	.687	171	174.2	6.28	402.1	50.30	285.2
	80	21.564	1.218	297	158.2	6.28	365.2	87.17	472.8
	160	19.376	2.312	536	127.7	6.28	294.9	157.5	780.8

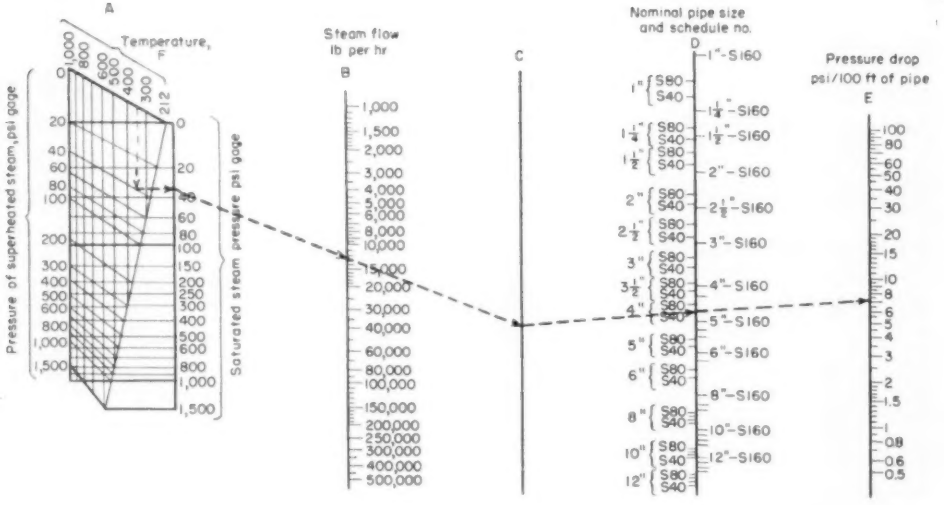
WATER-FLOW CHART



AIR-FLOW CHART


Initial air pressure, lb per sq in abs
Internal pipe diameter, in
Cfm air at pressure P_1 and 70 F
Pressure drop, lb per sq in per 1000 ft
X
X

STEAM-FLOW CHART



USING CHARTS

For fluids flowing in pipes, *pressure drop*, psi per 100 ft, equals 0.0864 times *friction factor* times *fluid density*, lb per cu ft, times the *square of the flow*, gal per min, *divided* by the *fifth power of the inside diameter*, inches. Friction factors depend in turn on rate of flow, fluid density, viscosity (resistance to flow) and pipe roughness. Charts given here assume an average friction factor, and are for estimating only. Many piping manufacturers publish more comprehensive charts that allow for varying friction.

WATER-FLOW CHART. Draw line from gpm through internal diameter to find head loss. Use chart page 99 to convert to psi. Head loss will be less for very smooth new pipe or very warm water, greater for rough pipe, cold water.

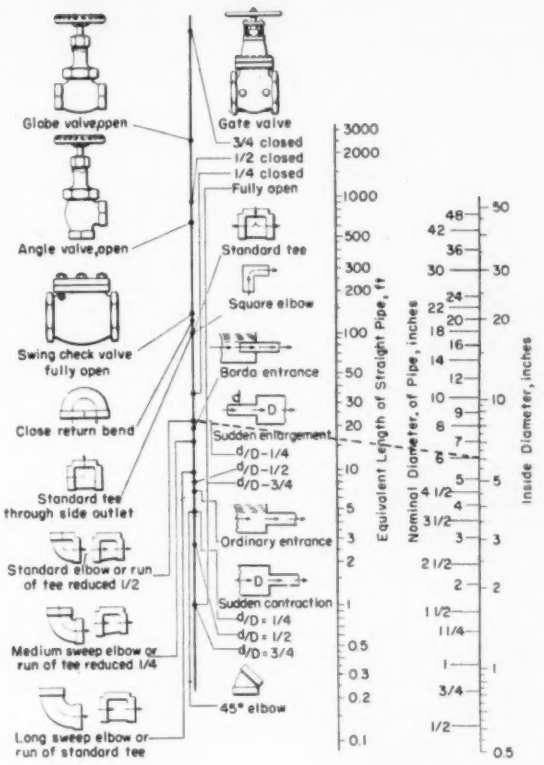
AIR-FLOW CHART. Draw line from initial pressure to cfm flow. Draw second line from internal diameter through intersection to find pressure drop. At temperatures above 70 F, pressure loss will be less, but lb of air flow will also be less for *same cfm flow*. Below 70 F, pressure drop and lb flow are greater.

STEAM-FLOW CHART. Enter with initial temperature, follow down to diagonal pressure line, then straight out to saturation line. From here draw through flow to dummy; then from dummy through pipe size to pressure drop.

FITTING RESISTANCE. Connect fitting with nominal pipe size to find equivalent length of straight standard pipe. Add to actual length of pipe for figuring total pressure drop. Chart shows 6-in. std elbow equals 16 ft pipe.

FRICTION LOSS IN PIPE FITTINGS

(From Technical Paper No. 409, copyright Crane Co)



PIPING AND FLOW PROBLEMS

Solutions to first three problems are shown on charts on facing page.

EXAMPLE. What is the head loss per 1000 ft of pipe when 1000 gpm flows through 8-in. ID pipe?

Solution: Drawing line from 1000 gpm on flow scale through 8 in. on pipe scale gives 22 ft head loss per 1000 ft, or about 9.6 psi drop (from chart p 99).

EXAMPLE. A 600-ft straight air line made of 5-in. ID pipe delivers 500 cfm from receiver at 135 psi gage. What is pressure at discharge?

Solution: Abs pressure is about 150 psi. Connect 150 psi to 500 cfm. Draw second line from 5 in. ID through intersection of first line with dummy to read pressure loss of 20 psi per 1000 ft. Total pressure drop is $20\times600\div1000=12$ psi. Outlet is $135-12=123$ psi gage.

EXAMPLE. If 12,500 lb per hr of steam starting at 40 psi gage and 350 F flow through 50 ft of 4 in. schedule-40 pipe, what is total pressure drop if line contains a wide-open gate valve and two standard elbows?

Solution: Chart shows 7.2 psi drop per 100 ft. Total equivalent length of pipe is 50 plus 2.3 for the gate valve plus $2\times12=24$ for the two elbows or 76.3 ft total. $7.2\times76.3\div100=5.5$ psi.

EXAMPLE: What is the bending stress at each anchor of a 15 ft span of 3-in. schedule-40 pipe full of water?

Solution. Table on page 101 lists weight of pipe as 7.57 lb per ft and weight of water in pipe as 3.20 lb per ft. Total weight between supports is $15\times(7.57+3.2)=162$ lb. Using formula for uniformly loaded beam supported at each end, page 85, moment equals $\frac{1}{8}\times15\times162=304$ ft lb or 3648 in. lb. Section modulus from table, page 101, is 1.724. Stress $= 3648\div1.724=2116$ psi. Actual stress will be less because "beam" is continuous over supports.

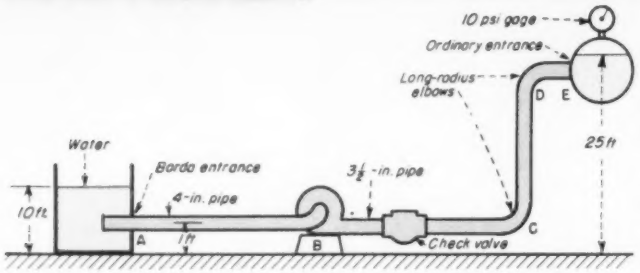
EXAMPLE: If a short length of carbon-steel pipe, anchored rigidly, were heated from 100 F to 450 F without allowing to expand, what stress would be set up? Modulus of elasticity averages 29 million psi for these temperatures.

Solution. From *thermal expansion* table page 101, pipe could have expanded $3.5-0.5=3.0$ inches per 100 ft (1200 in.). Stress (see *stretching of materials* page 84) equals $29{,}000{,}000\times3.0\div1200=72{,}500$ psi. Pipe would probably break before reaching 450 F.

EXAMPLE: A 50-ft long, 2-in. sched-40 pipe connects boiler at 100 psi gage, 500 F to accumulator at 90 psi gage. Neglecting line heat loss, what is flow?

Solution. Pressure drop is equivalent to 20 psi per 100 ft. Draw line from 20 through pipe size to dummy line C. Draw line from this point on C to 100 psi gage and 500 F. Intersection on steam-flow line reads 5000 lb per hr.

MORE PROBLEMS



EXAMPLE: How much head does above pump have to overcome (neglecting its own losses) to deliver 200 gal per min? Distance A to B is 25 ft, B to C is 25 ft, C to D is 22 ft, D to E is 10 ft. Pipe is schedule 40. If pump is 70% efficient, what hp is needed?

SOLUTION: Find total head at pump discharge, subtract total head at suction to get net head supplied by pump.

Suction Head. Static or elevation head is 9 ft. Pressure head is zero. Equivalent length of "borda entrance" is 10 ft for 4 in. pipe from chart page 103. Total equivalent length of suction piping is 25+10=35 ft. Head loss for 200 gpm flow through 4-in. pipe from chart page 102 is 29 ft per 1000 ft of pipe. So friction head is 35×29÷1000=1.02 ft.

Total head at suction equals static head *minus* friction head or 9−1.02=7.98 ft total suction head.

Discharge Head. Static or elevation head is 24 ft. Pressure of 10 psi is equivalent to 23 ft pressure head (from chart page 99). To find velocity head, first convert gallons per minute to cu ft per sec and divide by the inside cross-section area in square feet to get velocity in feet per sec, then use chart page 99 to read velocity head directly in feet. Flow of 200 gpm equals 0.00223×200=0.446 cu ft per sec (see page 98 for conversion table). Inside section area of 3½-in. pipe is 9.89 sq in., or 0.0686 sq ft, so velocity is 0.446÷0.0686=6.5 ft per sec. Velocity head from chart at the top of page 99 is then 0.67 ft.

Total straight run of pipe is 25+22+10=57 ft. Each long-radius elbow is equivalent to 4.4 ft of 3½-in. pipe; check valve is equivalent to 22 ft and entrance to tank is equivalent to 5 ft. Total equivalent length is 57+4.4+4.4+22+5=92.8 ft. Chart page 102 gives head loss for 200 gpm flow through 3½-in. pipe as 60 ft per 1000 ft. So friction head equals 92.8×60÷1000=5.57 ft. Total discharge head equals static plus pressure plus velocity plus friction = 24+23+0.67+5.57=53.2 ft.

Net Head. Head supplied by pump is discharge head minus suction head or 53.2−7.9=45.3 ft head. (Note: Velocity head was very small compared to other heads. For most pump calculations, velocity head may be ignored *except* where velocity is important such as when feeding hoselines, etc.)

Pump Power. From chart on page 100, a 70% efficient pump delivering 200 gpm against 45-ft head takes 3¼ hp.

TANKS

Table below gives capacity per inch for flat-ended tanks only. For bumped (convex) heads add ⅓ depth of each head; for dished heads, subtract ⅔.

EXAMPLE: *How many gallons will a horizontal 64-in. ID tank hold if straight part is 120 in. long and two bumped heads are each 6 in. deep?* Two-thirds of 6 is 4, so equivalent length is 120+4+4=128 in. Capacity per inch from table below is 13.93 gal. Tank holds 128×13.93=1783 gal. *How many gallons will fill tank 25 in. deep?* Fraction full by depth is 25÷64=0.39. Volume fraction is 0.361, so tank holds 0.361×1783=643 gallons.

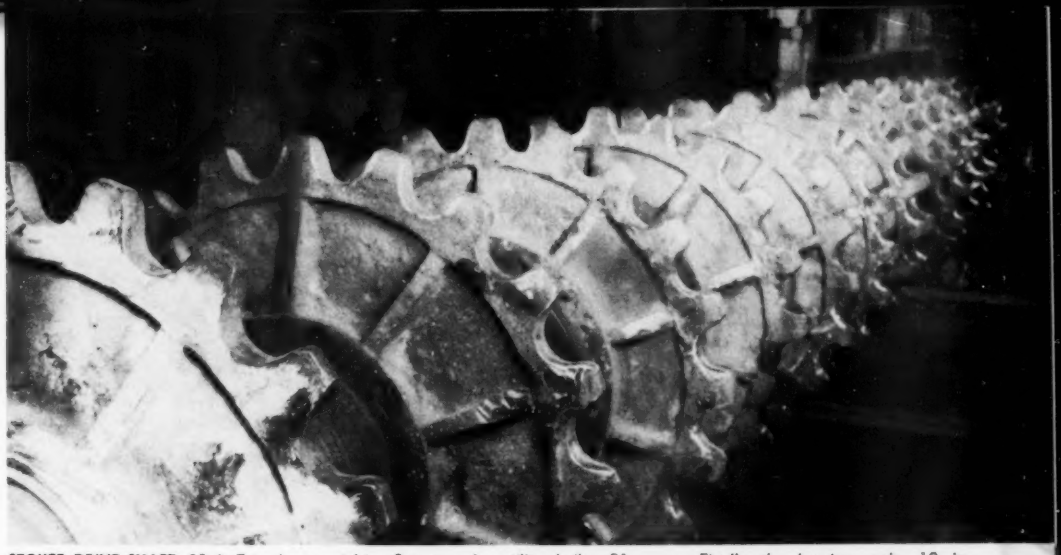
PARTLY FULL HORIZONTAL CYLINDRICAL TANKS

(Fraction full by depth and by volume)

By depth	By volume	By depth	By volume	By depth	By volume	By depth	By volume	By depth	By volume	By depth	By volume
.01	.0017	.18	.1224	.35	.3119	.51	.5128	.68	.7241	.85	.9059
.02	.0044	.19	.1323	.36	.3241	.52	.5255	.69	.7360	.86	.9149
.03	.0087	.20	.1424	.37	.3364	.53	.5383	.70	.7477	.87	.9236
.04	.0134	.21	.1526			.54	.5510	.71	.7593	.88	.9320
.05	.0187	.22	.1631	.38	.3487	.55	.5636	.72	.7708	.89	.9401
.06	.0245	.23	.1737	.39	.3611	.56	.5763	.73	.7821	.90	.9480
.07	.0308	.24	.1845	.40	.3736	.57	.5889	.74	.7934	.91	.9554
.08	.0375	.25	.1955	.41	.3860	.58	.6014	.75	.8045	.92	.9625
.09	.0446	.26	.2066	.42	.3986	.59	.6140	.76	.8155	.93	.9692
.10	.0520	.27	.2179	.43	.4111	.60	.6264	.77	.8263	.94	.9755
.11	.0599	.28	.2292	.44	.4237	.61	.6389	.78	.8369	.95	.9813
.12	.0680	.29	.2407	.45	.4364	.62	.6513	.79	.8474	.96	.9866
.13	.0764	.30	.2523	.46	.4490	.63	.6636	.80	.8576	.97	.9913
.14	.0851	.31	.2640	.47	.4617	.64	.6759	.81	.8677	.98	.9952
.15	.0941	.32	.2759	.48	.4745	.65	.6881	.82	.8776	.99	.9983
.16	.1033	.33	.2878	.49	.4872	.66	.7002	.83	.8873	1.00	1.000
.17	.1127	.34	.2998	.50	.5000	.67	.7122	.84	.8967		

CAPACITY OF FLAT-ENDED CYLINDRICAL TANKS PER INCH OF LENGTH

Dia In.	Volume Cu Ft	Gal	Lb Water 60 F	Dia In.	Volume Cu Ft	Gal	Lb Water 60 F	Dia In.	Volume Cu Ft	Gal	Lb Water 60 F	Dia In.	Volume Cu Ft	Gal	Lb Water 60 F	Dia In.	Volume Cu Ft	Gal	Lb Water 60 F
10	.04545	.3399	2.835	26	.3072	2.298	19.16	42	.8017	5.997	50.00	58	1.529	11.44	95.36	78	2.765	20.69	172.5
11	.05499	.4114	3.430	27	.3313	2.478	20.66	43	.8404	6.286	52.42	59	1.582	11.83	98.67	81	2.982	22.31	186.0
12	.06545	.4896	4.082	28	.3563	2.666	22.22	44	.8798	6.582	54.88	60	1.636	12.24	102.0	84	3.207	23.99	200.0
13	.07683	.5741	4.792	29	.3822	2.859	23.84	45	.9204	6.886	57.41	61	1.691	12.65	105.5	87	3.440	25.73	214.6
14	.08908	.6666	5.556	30	.4091	3.060	25.52	46	.9617	7.194	59.98	62	1.747	13.07	109.0	90	3.682	27.54	229.6
15	.1022	.7650	6.374	31	.4367	3.267	27.24	47	1.004	7.511	62.62	63	1.804	13.49	112.5	93	3.931	29.41	245.2
16	.1163	.8700	7.254	32	.4654	3.482	29.03	48	1.047	7.833	65.30	64	1.862	13.93	116.2	96	4.189	31.33	261.3
17	.1313	.9824	8.189	33	.4950	3.702	30.87	49	1.091	8.163	68.05	65	1.920	14.36	119.8	99	4.455	33.32	277.9
18	.1472	1.102	9.181	34	.5254	3.930	32.77	50	1.136	8.500	70.85	66	1.980	14.81	123.5	102	4.729	35.37	294.9
19	.1641	1.227	10.23	35	.5567	4.165	34.72	51	1.182	8.843	73.72	67	2.040	15.26	127.2	105	5.011	37.48	312.5
20	.1818	1.360	11.34	36	.5891	4.406	36.74	52	1.229	9.193	76.65	68	2.102	15.72	131.1	108	5.301	39.66	330.6
21	.2004	1.499	12.50	37	.6222	4.655	38.81	53	1.277	9.550	79.65	69	2.164	16.19	135.0	111	5.600	41.89	349.3
22	.2200	1.646	13.72	38	.6563	4.910	40.93	54	1.325	9.913	82.64	70	2.227	16.66	138.9	114	5.906	44.18	368.4
23	.2404	1.798	14.99	39	.6913	5.171	43.12	55	1.375	10.28	85.76	71	2.291	17.14	142.9	117	6.221	46.54	388.0
24	.2618	1.958	16.33	40	.7272	5.440	45.36	56	1.425	10.66	88.88	72	2.356	17.63	146.9	120	6.545	48.96	408.2
25	.2841	2.125	17.72	41	.7640	5.715	47.65	57	1.477	11.05	92.12	75	2.557	19.12	159.5				



STOKER DRIVE SHAFT, 23 ft 7 in. long, weighing 9 tons and carrying 14 cast-iron sprockets, had served on an East Coast utility boiler 21 years. Finally the bearing ends, 10 in. dia originally, wore down to where the shaft seemed doomed

Stoker Drive Shaft Saved by Welding

G S McGINLEY, *District Engineer, Eutectic Welding Alloys Corp*

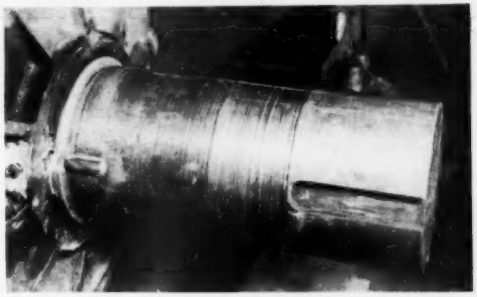
► WHEN A 9-TON, 23-FT 7-IN. STOKER drive shaft wears down to the point where it needs replacing or repairing it poses a highly specialized problem. That's what happened in one large East Coast utility power plant.

Their particular shaft, *above*, had been in service 21 years and it had worn down so badly at the bearing ends that it was no longer usable, photo right. The company's management felt a repair job was too big for their own plant.

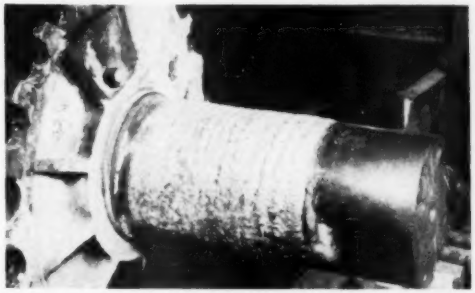
But they decided to look into welding. Out of this investigation came the decision to use Eutecrod 185 FC, a patented alloy known as Bronzochrom. This alloy bonds with the parent metal at between 1000 and 1200 F.

To perform the welding operation with the least damage to the shaft an improvised jig was set up with the cast-iron sprockets left in place. A heavy V-belt sling arrangement in conjunction with large roller bearings permitted turning the shaft slowly during heating and welding. Large oxyacetylene torches were applied with every care taken not to raise shaft heat above a cherry red in color.

The job got under way at the end of a day shift and was finished in 8 hr by three of the company's regular employes. Later, an outside firm did the after-machining, using a portable jig.



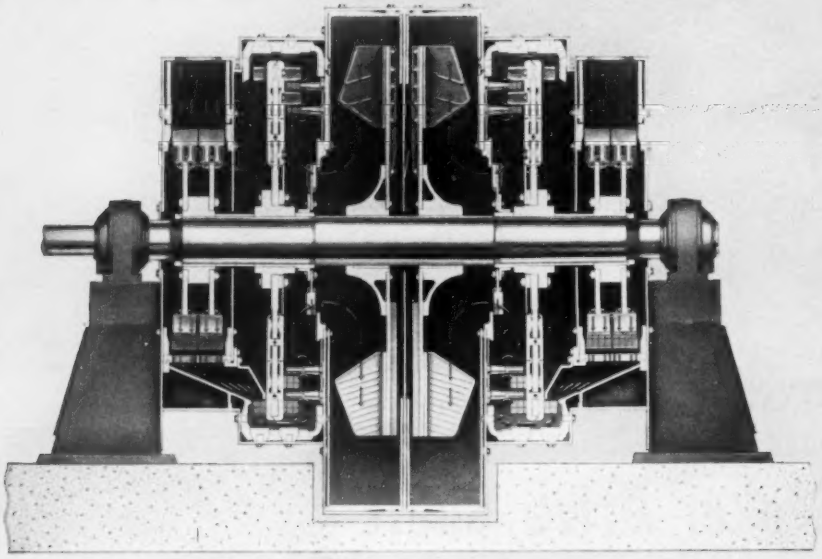
BEARING END of worn-down shaft shows how far down the shaft metal had gone and the size of the job expected of welding



WELDING with oxyacetylene torches and the Eutecrod 185 FC, made of the alloy Bronzochrom, took 8 hr and 18 lb of rod

MACHINING to final dimensions was done by outsiders with a portable jig. Shaft alignment was only 0.004 in. out of line

The NEW "50" Series Riley Pulverizer

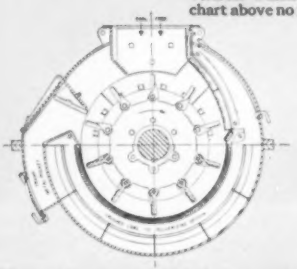


Pulverizing parts faced with Tungsten Carbide

Long periods continuous operation
Low maintenance . . . Sustained fineness

Development of the use of tungsten carbide faced pulverizer parts was started by Riley over ten years ago. Hundreds of existing Riley pulverizers have been equipped. The use of tungsten carbide adds tremendously to the life of the parts. While Riley pulverizers have been in operation for over two years and have pulverized in excess of 50,000 tons of coal, wear of the tungsten carbide is scarcely measurable. These parts are good for many more years of service.

The use of tungsten carbide not only assures long continuous periods of operation without maintenance shutdowns, but because of the extremely long life, greatly reduces maintenance cost per ton of coal pulverized. Fineness of pulverization is sustained without any adjustments whatsoever. You will note from the chart above no reduction in fineness though practically 50,000 tons of coal have been pulverized.



Preliminary Crusher-Dryer Section

No capacity reduction with high moisture coals
Complete reliability

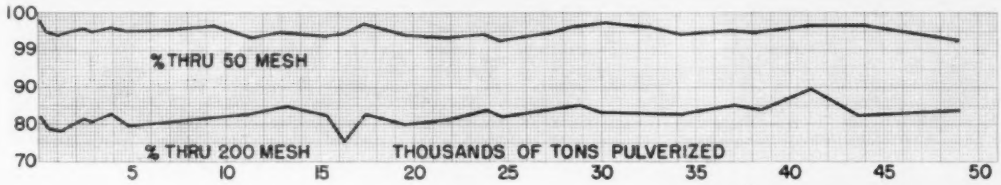
Provided air or furnace gas of sufficient temperature is supplied, there is no capacity reduction with increased moisture content of the coal. The crusher section acts as a flash dryer. In this section coal is crushed to a fine granular state, approximately 40% through a 50-mesh screen, representing about 5% of the work to be done. Coal enters the pulverizing section where 95% of the work is done, with free moisture evaporated from the coal, consequently moisture content of the coal entering the crusher section has no effect on pulverizer capacity.

The crusher section of the pulverizer rejects tramp iron, iron pyrites and other hard foreign substance in the coal, preventing any materials from entering the pulverizer section which could cause damage.

RILEY STOKER CORPORATION
WORCESTER, MASS.

BOILERS • PULVERIZERS • BURNERS • STOKERS • SUPERHEATERS • FLUE GAS SCRUBBERS

a most significant Pulverizer Development



Other Operating Advantages

in addition to long life, low maintenance, sustained fineness of pulverization . . . no capacity reduction with high moisture coals and complete reliability

Flexibility—Wide Load Range

As change in coal feed gives instantaneous corresponding change in pulverized coal output—there is no lag—rapidly and widely fluctuating loads are efficiently and easily carried.

Ability to Carry Low Loads

With the combination of Riley pulverizers and burners, extremely low loads with stable ignition can be maintained. It is not unusual for load ranges of 10 to 1 or for loads under 5000 pounds of steam per hour to be carried at Riley installations.

High Primary Air Temperatures

There is no necessity of limiting primary air temperatures as a precaution against fire or explosion or because of lubricating problems. Expensive control equipment limiting primary air temperatures is not required.

Ease of Lighting

Because of small percentage of primary air, a rich and readily lighted mixture of air and coal is obtained which together with the uniform distribution with Riley burners makes lighting easy and gives stable flame at low loads.

Quiet, Vibrationless Operation

There is no comparison between Riley pulverizers and other makes insofar as quiet vibrationless operation is concerned. You hear nothing more than a motor hum.

Small Space Required—Minimum Foundations

Riley pulverizers require less space per unit of capacity. Massive deep foundations are not required due to their vibrationless quiet operation.

Explosion Proof

There has never been an explosion in a Riley pulverizer. The velocity of coal travel through the pulverizer is faster than the rate of flame propagation, eliminating the possibility of an explosion.

Here is what one user has to say about his Riley pulverizers after equipping them with tungsten carbide parts:

Pleased to advise that in my opinion Riley Mills with carbide elements will outperform any mill today. Original parts installed Sept. 1948 are still going strong and fineness does not go below 80% through 200 mesh. Fully expect mill maintenance cost will run less than three cents per ton.

These companies have recently ordered new "50" Series Riley Pulverizers

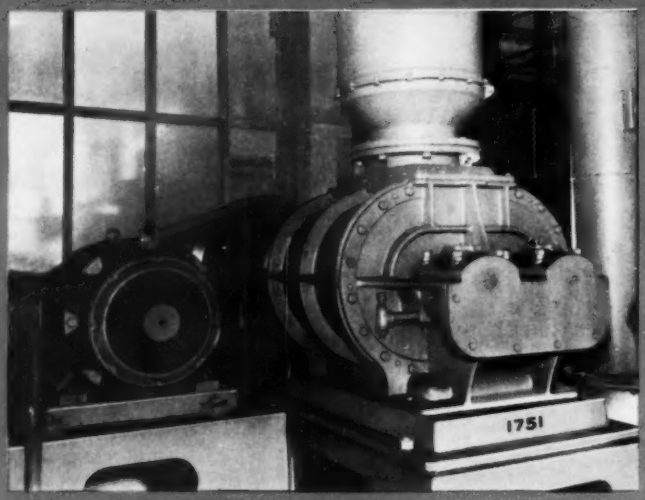
MONONGAHELA POWER COMPANY
Albright, W. Va.
IOWA-ILLINOIS GAS & ELECTRIC CO.
Davenport, Iowa
UTAH POWER & LIGHT CO.
Salt Lake City, Utah
SUPERIOR WATER, LIGHT & POWER CO.
Superior, Wisc.
WESTERN ELECTRIC CO.
Chicago, Ill.
CARNEGIE ILLINOIS STEEL CO.
Youngstown, Ohio
CELANESE CORP. OF AMERICA
Rock Hill, S. C.
PITTSBURGH PLATE GLASS CO.
New Martinsville, W. Va.
HOOKER ELECTROCHEMICAL CO.
Niagara Falls, N. Y.
U. S. FINISHING CO.
Norwich, Conn.
SYRACUSE UNIVERSITY
Syracuse, N. Y.
RIEGEL TEXTILE CORP.
Trion, Ga.
CITY OF AUSTIN
Austin, Minn.
CIBA STATES LTD.
Toms River, N. J.
BELL AIRCRAFT CORP.
Niagara Falls, N. Y.
POTOMAC LIGHT AND POWER CO.
Albright, West Va.
NORTHERN PAPER MILLS
Green Bay, Wisc.

A survey of your Power Plant by a consulting engineer will possibly show ways of making surprisingly large savings in power costs

COMPLETE STEAM GENERATING UNITS

ECONOMIZERS • WATER-COOLED FURNACES • STEEL-CLAD INSULATED SETTINGS • AIR HEATERS

NO V-P-L WORRIES WITH R-C BLOWERS



ROTARY

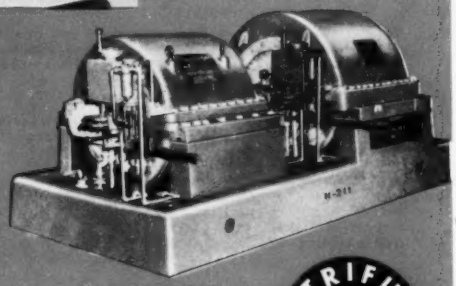
Rotary Positive Blower for pneumatic conveying in large eastern processing plant. Many other R-C units are used in various plants of this same company.

Today's production urgencies call for "no-vacation" performance from blowers and other equipment to move gas and air. You must be sure of positive Volume, at the required Pressure, and at Low power cost to keep down rising expenses. The answer is Roots-Connersville Blowers with V-P-L.

You obtain this freedom from worry whether you install R-C Centrifugal or Rotary Positive equipment. This exclusive *dual-ability* gives you the choice of either type to best meet your requirements. Wide latitude in sizes, from 5 cfm to 100,000 cfm, permits selection of units with capacities close to your specific needs. Often, this flexibility saves time, cost, space, weight and power charges.

R-C engineers will gladly counsel with you on any problem of moving or measuring gas or air to keep production going.

ROOTS-CONNERSVILLE BLOWER CORPORATION
510 Powell Avenue, Connersville, Indiana



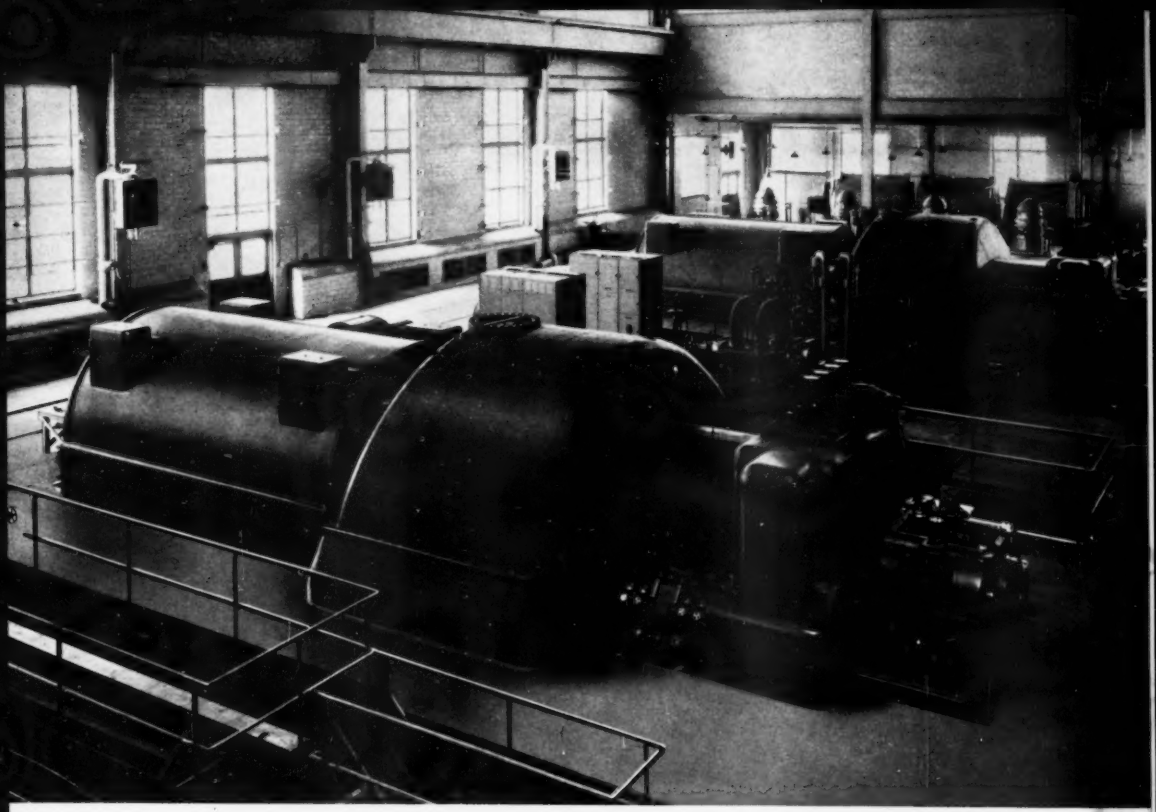
Two, 4-Stage, Type N Centrifugal Compressors, mounted on common base. Motor driven, with capacities of 11,230 cfm and 8,990 cfm, respectively.

CENTRIFUGAL

ROOTS-CONNERSVILLE

BLOWER BUILDERS SINCE 1854

ONE OF THE DRESSER INDUSTRIES



Over 250,000-KW Capacity Operating on . . .

NONPAREIL
TRADE MARK
Turbine Oil

● With the installation of a 45,000-KW turbine shown in the foreground of the illustration above, a large midwest utility now has six large turbines — over 250,000-KW capacity — operating on NONPAREIL Turbine Oil.

There is reason to believe that this new turbine will never have to be shut down for oil replacement, oil-system cleaning, or because of oil-acidity troubles. This conviction is based on the lubrication record of NONPAREIL Turbine Oil in this plant.

•

During *ten years of operation*, neutralization numbers have stayed below .07 mg. KOH/gm. There have been no time losses or troubles caused by high acidity. Oil systems have stayed clean. Such benefits are assured this company, not only for 10 years, but for the *life* of its turbines. This assurance is based on NONPAREIL's written guarantee that it will maintain a neutralization number below 0.15 mg. KOH/gm.

WITH NO OIL-ACIDITY OR OIL-REPLACEMENT WORRIES

Why not end oil-system maintenance and oil-acidity troubles once and for all, by using NONPAREIL Turbine Oil in your turbines? For more evidence of these savings, ask a Standard Oil Lubrication Engineer to supply you data from 23-year service records of NONPAREIL Turbine Oil.

• • •

Write Standard Oil Company (Indiana), 910 South Michigan Avenue, Chicago 80, Illinois.

STANDARD OIL COMPANY (INDIANA)

STANDARD

NOW more important than ever to you

You are, or may soon be, shifting your production setup to meet the country's rearmament needs. New machines, new operations, and faster production schedules will demand some revision of your lubrication practices. That's why Standard's Service-Supply organization is now more important than ever to you.

Standard has a service-supply warehouse within a short truck-hauling distance from your plant.

If you are a Standard Oil customer this warehouse will stock every lubricant used in your plant. Deliveries can be made in a few hours if necessary.

In addition, this service-supply center is headquarters for a Standard Oil lubrication specialist who is assigned to your plant. He is close at hand to give you help when you need it. He has plenty of practical experience. He has been specially trained for his job in a Standard Oil Lubrication Engineering School. He is backed by Standard Oil's extensive research and technical facilities.

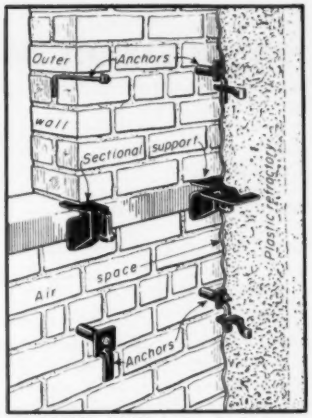
To arrange for his visit, phone your nearby Standard Oil Service-Supply center or write to: Standard Oil Company (Indiana), 910 South Michigan Avenue, Chicago 80, Illinois.

STANDARD

STANDARD OIL COMPANY (INDIANA)

Originally developed as flexible and convenient patching agent for furnace linings, this material is now used to build complete monolithic enclosures as well as suspended arches. These high-temperature materials can be applied to all sizes of furnaces, including central-station giants, because . . .

. . . Plastic Refractories Are Versatile Performers



AIR-COOLED WALL built of plastic refractory uses anchors, sectional supports

► PLASTIC REFRACTORIES are made of several different materials including fire clay, flint clay, alumina, silica, chrome, kaolin, etc. The composition selected depends on furnace conditions. As the name implies the refractory comes in plastic moldable form. It has the consistency of stiff putty and may be packed in small drums or cartons. In the latter the refractory is usually sliced into slabs 2 in. thick. Packing normally minimizes the refractory's drying out when in storage. But if it does dry out it can be restored to original condition by moistening with a small amount of water.

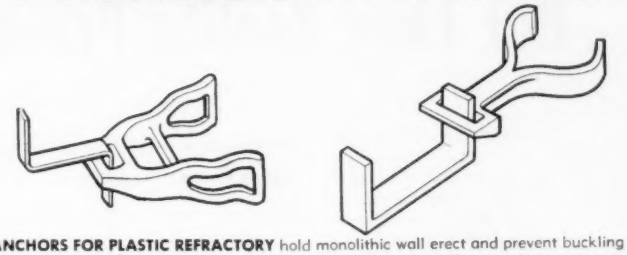
Refractory Duties. Plastic refractories do a good job in a furnace when compared with their principal duties:

1. Confine the combustion process and its products.
2. Control and direct heat flow.
3. Prevent air leaking into furnace and gas passages.
4. Resist destructive erosion and corrosive effects of combustion products.
5. Develop strength at high temperatures to resist upsetting forces.
6. Expand and contract freely with temperature changes.

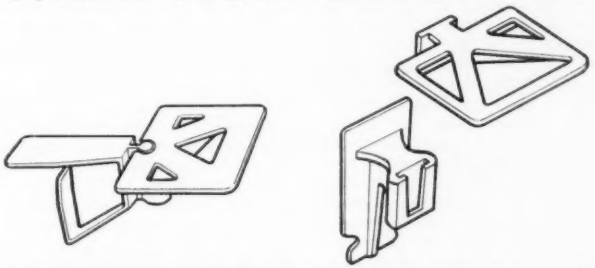
Let's look at how plastic refractory does each job. Confining combustion process and products is no problem for monolithic floors and walls of furnaces built from plastic refractories. For monolithic construction the plastic refractory is laid up in 2-in.-thick layers, each pounded and rammed into place with steel hammers wielded by hand or with air hammers. This binds the plastic layers into a solid mass, which prevents any air infiltration.

For a wall or section built with plastic material, the furnace is initially

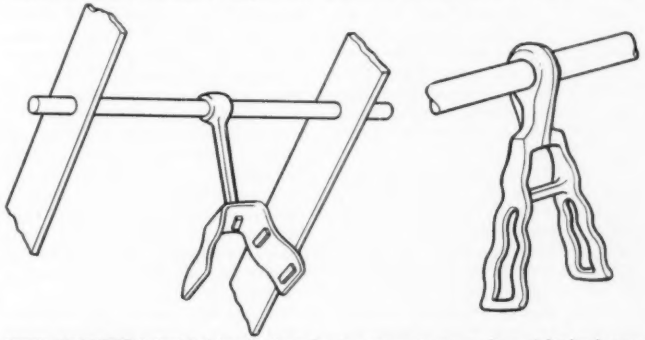
(Continued on page 170)



ANCHORS FOR PLASTIC REFRACTORY hold monolithic wall erect and prevent buckling by tying to outer brick wall or steelwork. They allow thermal expansion movement

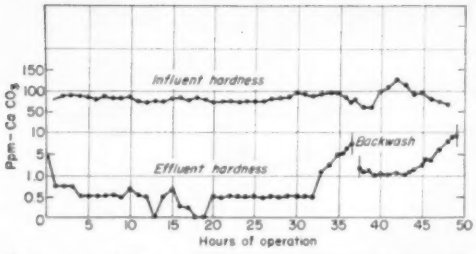


SECTIONAL SUPPORTS TRANSMIT refractory weight to outer wall or steelwork. Though they carry refractory weight they allow it to expand upward where needed



ARCH ANCHORS imbedded in plastic refractory serve to carry its weight by hanging from rods supported by outer steelwork. Slight movement allowed for expansion

HOT-LIME-ALUMINATE HOT-STYRENE SOFTENING WITH HIGH NONCARBONATE WATERS



1 Hourly analyses, run on influent and effluent of secondary exchanger, show system holds up under high hardness water

REGENERATION AND OPERATING CAPACITY OF THE HOT STYRENE ION EXCHANGER FOR CYCLE IN CHART

Cubic feet styrene resin	60
Pounds sodium chloride	600
Pounds regenerant per cubic foot resin	10
Sodium chloride to cation exchanger—%	20
Maximum concentration regenerant effluent—%	12
Brine contact period—minutes	40
Gallons water treated	302,000
Grains hardness removed—composite analysis	1,485,000
Operating capacity—grains per cu ft as $CaCo_3$	24,800
Operating efficiency—pounds per kilogram	0.40
Operating rate of flow range—gpm per sq ft	3.1

Hot Lime Zeolite Proves Practical

Dow Chemical Co at Ludington, Mich. reports on these solid advantages: simplified chemical control, improved silica removal and lower primary softener turbidities, positive hardness reduction by ion exchange, minimum CO_2 in steam

By L F WIRTH, Jr, *National Aluminate Corp*
W S BUTLER, *Dow Chemical Co*

► Dow Chemical Co put its Ludington, Mich. plant into operation in 1943 for the express purpose of supplying much needed magnesium for the then current national emergency. Operation was resumed in 1948 with a revision in process. The nature of the load demand had changed and along with it the requirements for additional boiler feedwater of better quality.

In 1943, a hot lime-soda-phosphate system was selected to supply 125,000 lb per hr of treated water at 230 F. Average makeup drawn from the Pere Marquette River ran about 25% for the two 425-psig 225,000-lb-per-hr steam generators. Under average operating conditions the treated water ran as shown in table on p 112 as *Condition A*.

Total hardness was reduced this way from 167 ppm average as $CaCo_3$ down to 3 in the phosphate softener effluent. Of this 1 ppm was magnesium. Silica went from 5 ppm down to 2. Turbidity out of the phosphate softener averaged 50 ppm. Frequent fouling of filters and outages of boilers for mechanical and chemical cleaning developed from this high turbidity. Further, carbon dioxide content of steam under these conditions amounted to 4 ppm.

When the 1948 plant operation program came into effect, production had shifted to chemical items, not magnesium, requiring more process steam. This brought makeup needs up another 40,000 to 50,000 lb per hr—considerably beyond the existing system capacity.

Several possible solutions were considered: (1) Extend the existing system. (2) Put in an acid cycle cation exchanger followed by decarbonization. (3) Go to deionization. (4) Install cold-process lime-soda softening followed by sodium cycle cation exchange. (5) Redesign to include a styrene-type resinous exchange material as a secondary softener following the hot lime-soda process. This last solution had at that time only pilot plant studies to back it up.

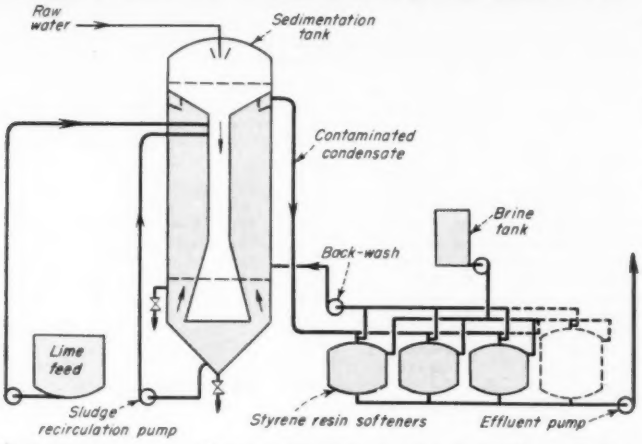
In fact, these pilot-plant studies had not progressed to the point where their data could be applied to a full-scale softening system. So we went ahead on the redesign with considerable caution.

Treatment Equipment. By December 1949 three 6-ft 6-in. filter shells, a part of the original system, were converted to high-temperature ion-exchange softeners. We removed the old filtering medium and put in 21-in. beds of styrene-resin ion-exchange material above a 10-in. layer of graded anthracite. The 4-ft side-sheet height of the filters proved the controlling factor on the exchanger bed depth in this particular conversion.

We were now ready to put into effect a hot lime-soda softening system followed by hot styrene-resin exchange, *Condition B* in table on p 112. This system ran for 41 days. Total hardness dropped from a raw water average of 167 ppm as $CaCO_3$ to 1.8 ppm in the secondary effluent as against 3 ppm in *Condition A*. Magnesium hardness represented 0.6 ppm of this 1.8 as against 1 in *Condition A*. Turbidity from the primary softener showed up at 40 ppm as SiO_2 against 50 in the previous system. Silica reduction was negligible and average CO_2 content of boiler steam went up to 5 ppm from a previous 4.

We were anxious for improvement in hardness, silica and turbidity in the final treated water. To that end we started feeding 15 ppm of sodium aluminate to the primary softener with the lime. *Condition C*, table on p 112, gives the average results obtained over a 50-day trial period. Total hardness dropped to 0.6 ppm in the secondary softener effluent from a 167-ppm start in the raw water. Of this 0.6 ppm, 0.1 was due to magnesium. Silica reduction was from 3 ppm in the primary softener influent to 0.8 ppm in the secondary softener effluent. Turbidity of primary softener effluent averaged 4 ppm as SiO_2. Carbon dioxide, however, in boiler steam stayed up around 5 ppm.

PROPOSED SOFTENING SYSTEM PROMISES GOOD RESULTS



2 Projected layout of softening system going in shows an additional 6-ft 6-in. ion-exchange unit with a 30-in. exchanger bed, and three older units modified

We knew sludge blanket operation had improved hot-process softener performance in many cases, so why not here? By taking out the phosphate compartment and modifying our softener design we were able to incorporate the sludge blanket principle and sludge recirculation.

Chemical feed to the primary softener stayed the same, that is, we continued using lime, soda ash, sodium aluminate. Best results based on early experience came about by circulating 5% of the sludge from the bottom of the cone of the primary softener. *Condition D*, table on p 112, summarizes the results this system gave us for the 30 days we ran it.

Total hardness stayed the same as our results with *Condition C*. Silica in the secondary softener effluent showed a slight improvement, dropping to 0.7 ppm from the 3 ppm in the primary softener influent as against 0.8 with *Condition C*. Turbidity results from the primary softener effluent were even better. They averaged 2 ppm as against 4 with *Condition C*. Carbon dioxide in the boiler steam showed a drop, going down to 3 from 5 ppm in *Condition C*.

Normal operation of a lime-soda softener entails maintaining an excess of carbonate alkalinity in the effluent to be sure of maximum noncarbonate hardness reduction. All the experience we could gather indicated that with a secondary hot styrene softener we could cut out soda-ash feed to the primary softener and use only lime and sodium aluminate. Further, we thought the ratio of magnesium and aluminum oxides in the sludge would increase as a result of decreased calcium carbonate precipitation and permit greater silica removal in the primary unit. Of most importance, cutting out soda-ash feed to the primary softener would greatly reduce carbon dioxide content of the steam.

Condition E, table on p 113, lists results of 51 days' operation of the lime-sodium aluminate-styrene-resin secondary softener. Total hardness went from 167 ppm in the raw water down to 0.5 ppm in the secondary softener effluent, with about 0.1 ppm of this hardness due to magnesium. Silica reduction went from 3 ppm in the primary softener influent down to 0.5 in the secondary effluent compared to 0.5 in *Condition D*. Turbidity at the effluent of the primary softener averaged 0.7 ppm. Carbon dioxide ran 1.0 ppm in this period.

From this essentially cut-and-try method of approaching our feedwater-treatment problems we developed at first-hand the experience to appraise the advantages of a lime-aluminate softener when followed by a hot-styrene ion-exchange unit.

Treatment Advantages. Principal advantages are: (1) Simplified chemical dosage control: A single chemical feeder can supply both lime and sodium aluminate. (2) Improved silica removal and lower primary softener turbidities —probably due to higher concentrations of magnesium and aluminum oxides in the sludge. (3) Effective correction of lime-aluminate softener effluent hardness: Secondary ion-exchange softener reduces hardness to extremely low values regardless of incidence, type or quantity in the primary softener effluent. (This is an inherent secondary phosphate softener weakness because of lag due to retention time.) (4) Low-value control of magnesium content: Precipitation-type softeners required high hydrate excess often followed by acid to control this factor. (5) Minimum CO_2 content in boiler steam: Decreased corrosion of condensate return and preboiler systems result from lower CO_2. (Further, where magnetic iron-oxide deposits are caused by iron getting into the boiler feed, this reduces incidence and severity of such deposits by decreasing possibility of the iron forming.) (6) Low-pressure supply of sodium phosphate and other water-treatment chemicals without feed-system deposits: Avoids need for expensive, high-pressure pumps for this chemical feed.

The raw water from the Pere Marquette River has a relatively low noncarbonate hardness content, not at all typical of some waters treated by the hot-process system. So calcium chloride was fed to the influent of the primary softener for one operating cycle to see how the hot lime aluminate—hot styrene softening system—worked with a high noncarbonate hardness water, table, p 113, *Condition F*.

The following are our results. With a starting hardness of 211 ppm as $CaCO_3$ in the primary softener influent the effluent showed only 80 ppm of which 8 ppm was magnesium hardness. Total alkalinity averaged 20 ppm as $CaCO_3$—probably because of the relatively high excess calcium. The hot styrene-resin exchanger further reduced hardness to an average of 0.5 ppm with only 0.1 ppm due to magnesium. Silica reduction ran from 3 ppm in the primary softener influent to 0.5 ppm in the secondary softener effluent. Turbidity of the primary softener effluent averaged 1 ppm as SiO_2. Carbon-dioxide content of boiler steam did not go over 1.0 ppm throughout this period.

Fig. 1 shows results of hourly analyses of influent and effluent of the secondary hot styrene-resin exchanger during an entire high influent hardness operating cycle. The versenate method of hardness determination served as the test for these results. They were spot-checked for calcium with a flame spectrometer and for magnesium by a precise colorimetric method. This magnesium test is shown step by step in the last column. In addition, the required test chemicals are given.

Styrene Stability. How well does the styrene cation exchange resin hold up under actual operating conditions? At this plant the resin has exhibited the high stability characteristics predicted

in its early laboratory tests. After eight months of service the entire exchanger bed was transferred so the sub-fill and the bottom of the bed could be examined. What's more, a representative sample from the entire exchanger bed was given a full, critical laboratory examination.

This laboratory sample, "as received," was evaluated for capacity. A 10% solution of sodium chloride at a dosage equivalent to 15 lb per cu ft served as the generating solution. Capacity achieved was 33,000 gr per cu ft as $CaCO_3$—a capacity rating only reached by a resin free of chemical or mechanical fouling. This result varies with early published opinions that the ion-exchange resin would become encrusted with calcium carbonate and other insoluble materials under ordinary operating condition where no filtration takes place between primary and secondary softening units.

The reason for the cleanliness of the styrene spheres can be explained by the fact that when the water is reduced in hardness as it passes through the ion-exchange unit a continuous resolution of any precipitated calcium carbonate between the bead spaces occurs. Then it is immediately exchanged to sodium carbonate as evidenced by a slight increase in carbonate alkalinity of the water passing through the exchanger. So it seems possible that this added hardness can influence exchange capacity evaluations. In the light of this, periodic acid washing of the exchanger beds as recently recommended in published information may not be needed.

At the Ludington, Mich. plant of Dow Chemical all back-washing, brining and rinsing of the secondary softener has taken place at or near 230 F. Only 2% of the beads of the styrene resin were broken after eight months continuous service. This experience indicates that the spherical styrene resins do not deteriorate under elevated temperatures nor apparently under fairly wide temperature variations such as they would experience from alternate shutdown and operation of the exchanger.

Proposed Equipment. Fig. 2 shows the projected layout of the softening system being installed at this plant. Prolonged previous cut-and-try operation, often under adverse turbidity conditions indicates a successful future. We realize that the ion-exchange units would probably operate somewhat better with filters between the primary hot lime-aluminate softener and the secondary hot styrene-resin exchangers. But space just wouldn't allow it.

An additional 6-ft 6-in. ion-exchange

DEVELOPMENT STAGES SHOW IMPROVEMENT

CONDITION A Hot lime-soda softening, followed by phosphate softening (Maximum flow rate 125,000 lb per hour)

PPM		Raw water	Hot lime-soda softener effluent	Phosphate softener effluent	Boiler water	Boiler steam
Total hardness	as $CaCO_3$	167	35	3.0	0	—
Calcium hardness	as $CaCO_3$	108	27	2.0	0	—
Magnesium hardness	as $CaCO_3$	59	9	1.0	0	—
Phenolphthalein alkalinity	as $CaCO_3$	—	40	40	100	—
Methyl orange alkalinity	as $CaCO_3$	139	55	55	150	—
Hydroxide alkalinity	as $CaCO_3$	—	35	35	50	—
Phosphate	as PO_4	—	—	30	100	—
Silica	as SiO_2	4	2	2	20	—
Carbon dioxide	as CO_2	—	—	—	—	4
Dissolved solids		268	—	—	650	—
Turbidity	as SiO_2	3	27	50	—	—
Aluminia	as Al_2O_3	Tr	Tr	Tr	Tr	—
pH		8.6	10.0	9.8	11.0	—

CONDITION B Hot lime-soda softening followed by hot styrene-resin exchange softening

Total hardness	as $CaCO_3$	167	35	1.8	0	—
Calcium hardness	as $CaCO_3$	108	20	1.2	0	—
Magnesium hardness	as $CaCO_3$	59	15	0.6	0	—
Phenolphthalein alkalinity	as $CaCO_3$	—	25	25	110	—
Methyl orange alkalinity	as $CaCO_3$	139	55	59	150	—
Hydroxide alkalinity	as $CaCO_3$	—	5	9	70	—
Phosphate	as PO_4	—	—	—	25	—
Silica	as SiO_2	3	—	2.3	15	—
Carbon dioxide	as CO_2	—	—	—	—	5
Dissolved solids		268	—	—	675	—
Turbidity	as SiO_2	3	40	1	—	—
Aluminia	as Al_2O_3	Tr	Tr	Tr	Tr	—
pH		8.6	9.7	9.8	11.0	—

CONDITION C Hot lime-soda, sodium aluminate softening, followed by hot styrene-resin exchange softening

Total hardness	as $CaCO_3$	167	16	0.6	0	—
Calcium hardness	as $CaCO_3$	108	15	0.5	0	—
Magnesium hardness	as $CaCO_3$	59	1	0.1	0	—
Phenolphthalein alkalinity	as $CaCO_3$	—	40	40	300	—
Methyl orange alkalinity	as $CaCO_3$	139	60	64	320	—
Hydroxide alkalinity	as $CaCO_3$	—	20	16	280	—
Phosphate	as PO_4	—	—	—	35	—
Silica	as SiO_2	3	0.9	0.8	11	—
Carbon dioxide	as CO_2	—	—	—	—	5
Dissolved solids		268	—	—	600	—
Turbidity	as SiO_2	3	4	1	—	—
Aluminia	as Al_2O_3	Tr	1.5	1	4	—
pH		8.6	10.6	10.6	11.1	—

CONDITION D Hot lime soda, sodium aluminate softening, with sludge blanket, followed by hot styrene-resin exchange softening

Total hardness	as $CaCO_3$	167	23	0.6	0	—
Calcium hardness	as $CaCO_3$	108	20	0.5	0	—
Magnesium hardness	as $CaCO_3$	59	3	0.1	0	—
Phenolphthalein alkalinity	as $CaCO_3$	—	42	43	625	—
Methyl orange alkalinity	as $CaCO_3$	139	56	56	693	—
Hydroxide alkalinity	as $CaCO_3$	—	28	30	557	—
Phosphate	as PO_4	—	—	—	35	—
Silica	as SiO_2	3	0.8	0.7	9	—
Carbon dioxide	as CO_2	—	—	—	—	3
Dissolved solids		268	—	—	800	—
Turbidity	as SiO_2	3	2	0.5	—	—
Aluminia	as Al_2O_3	—	2.0	1.8	6	—
pH		8.6	10.4	10.4	11.2	—

FINAL SETUP HANDLES ALL WATER HARDNESS

CONDITION E Hot lime, sodium aluminate softening with sludge blanket followed by hot styrene-resin exchange softening

PPM		Raw water	Hot lime-aluminate softener effluent	Hot styrene-resin ion exchanger effluent	Boiler water	Boiler steam
Total hardness	as $CaCO_3$	167	34	0.5	0	—
Calcium hardness	as $CaCO_3$	108	27	0.4	0	—
Magnesium hardness	as $CaCO_3$	59	7	0.1	0	—
Phenolphthalein alkalinity	as $CaCO_3$	—	14	14	336	—
Methyl orange alkalinity	as $CaCO_3$	139	26	26	368	—
Hydroxide alkalinity	as $CaCO_3$	—	2	2.0	314	—
Phosphate	as PO_4	—	—	—	15	—
Silica	as SiO_2	3	0.6	0.5	10	—
Carbon dioxide	as CO_2	—	—	—	—	1
Dissolved solids		268	82	90	883	—
Turbidity	as SiO_2	3	0.7	0.3	—	—
Aluminia	as Al_2O_3	Tr	Tr	Tr	0.5	—
pH		8.6	10.3	10.3	11.3	—

COMPOSITION COMPARISON: Primary and secondary softener effluent

Condition of softener operation	Turbidity ppm SiO_2		Calcium ppm $CaCO_3$		Magnesium ppm $CaCO_3$		Aluminia ppm $CaCO_3$		Silica ppm SiO_2		Carbon-dioxide content of boiler steam ppm CO_2
	1st*	2nd**	1st*	2nd**	1st*	2nd**	1st*	2nd**	1st*	2nd**	
A	27	50	27	2.0	9.0	1.0	Tr.	Tr.	2.0	2.0	4
B	40	1	20	1.2	15.0	1.6	Tr.	Tr.	—	2.3	5
C	4	1	15	0.5	1.0	0.1	1.5	1.0	0.9	0.8	5
D	2	0.5	2.0	0.5	3.0	0.1	2.0	1.6	0.8	0.7	3
E	0.7	0.3	27	0.4	7.0	0.1	Tr.	Tr.	0.6	0.5	1

* Primary softener effluent ** Secondary softener effluent All CO_2 figures in steam pertain to 25% makeup

RAW WATER . . .

from Pere Marquette River has relatively low noncarbonate hardness content. So calcium chloride was fed to influent of primary softener used in *Condition E*, for one operating cycle to see how system worked with high noncarbonate water. Results below in *Condition F*, and in Fig. 1, p 110. They prove the system effectiveness.

CONDITION F Hot lime, sodium aluminate softening with sludge blanket followed by hot styrene-resin exchange softening

PPM		Modified raw water	Hot lime-aluminate softener effluent	Hot styrene-resin ion exchanger effluent	Boiler water	Boiler steam
Total hardness	as $CaCO_3$	211	80	0.5	—	—
Calcium hardness	as $CaCO_3$	177	72	0.4	—	—
Magnesium hardness	as $CaCO_3$	34	8	0.1	—	—
Phenolphthalein alkalinity	as $CaCO_3$	5	12	12	204	—
Methyl orange alkalinity	as $CaCO_3$	142	20	22	244	—
Hydroxide alkalinity	as $CaCO_3$	—	4	2	164	—
Phosphate	as PO_4	—	—	—	25	—
Silica	as SiO_2	3	0.6	0.5	—	—
Carbon dioxide	as CO_2	—	—	—	—	1
Dissolved solids		337	—	—	—	—
Turbidity	as SiO_2	3	1.0	0.3	—	—
Aluminia	as Al_2O_3	Tr	Tr	Tr	—	—
pH		8.4	10.4	10.3	11.3	—

unit with a 30-in. exchanger bed is going in. The three existing units are being modified by increasing the shell height so they can carry 30 in. beds too. These improvements will permit sustained production of 150,000 lb per hr of treated water with an average total hardness of less than 1 ppm at the nominal low rate of 3 gal per min per sq ft through the ion-exchange units.

The new unit can be put to work treating contaminated condensate from process otherwise wasted. All that it needs is a 3-in. line to the inlet manifold of the secondary softening units. This will reduce quantity of makeup and, in return, reduce the load in the primary hot lime-aluminate softener. A pH controller will maintain optimum conditions of alkalinity in the primary softener. This is made possible by eliminating soda ash.

Up to the present time this plant has operated unattended for 12 to 16 hr except for periodic inspection of the primary softener chemical-feed equipment. Once the pH controller starts working, precise alkalinity adjustments can be made automatically, which will further improve results.

From all evidence the following conclusions can be made: Hardness of the secondary softener effluent from a hot-lime-aluminate styrene-resin softener combination can be reduced to 0.4 ppm, 0.1 ppm of which is magnesium.

Silica reduction can be accomplished to 0.3 ppm as SiO_2. Sludge recirculation through the primary softener is usually necessary to effect this reduction.

Turbidity of the influent of this secondary softener can be kept below 1 ppm by feeding sodium aluminate together with lime to the primary softener. With such a low turbidity it appears possible to operate without intermediate filtration and periodic acid cleaning.

Carbon dioxide in the boiler steam, with lime and sodium aluminate as treating chemicals in the primary softener, stays at 1 ppm as CO_2. This helps in eliminating magnetic iron-oxide deposits in boilers where they result from corrosion of condensate return and preboiler systems.

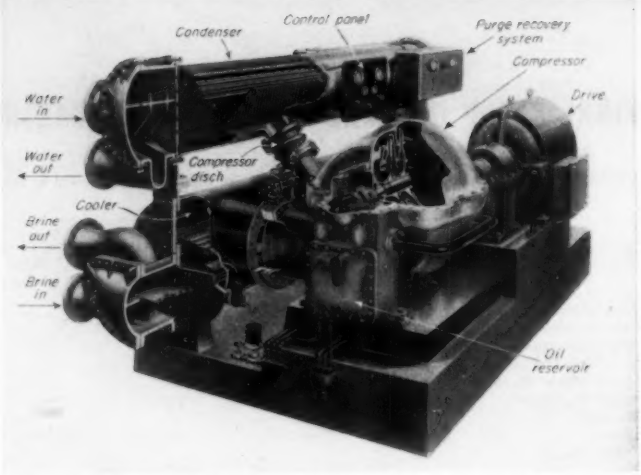
The *Composition Comparison* table, *above*, summarizes the operating experiences of our evolution from *Condition A*, hot lime-soda softening followed by phosphate softening to *Condition E*, our final hot-lime sodium-aluminate softening with sludge blanket followed by hot-styrene-resin exchange softening.

Magnesium Test. Colorimetric method developed by Nalco was the one we used for determining low magnesium

(*Continued on page* 174)

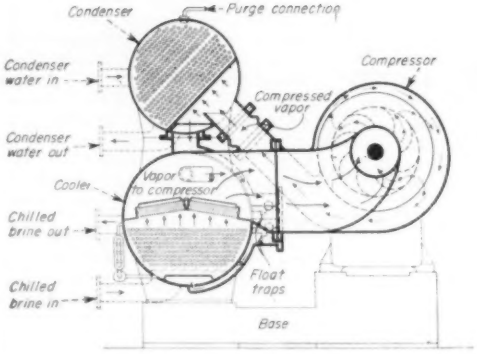
By **JAMES G MANNING**
Carrier Corporation

To get most from your hard-working centrifugals on refrigeration jobs you must keep them in good condition at all times. First of series covering maintenance and operation, this article deals with the seven major components of centrifugals, helps you to . . .



CUTAWAY OF CENTRIFUGAL REFRIGERATION SYSTEM shows principal components used in modern units for refrigeration service of many kinds. Turbine or motor drive

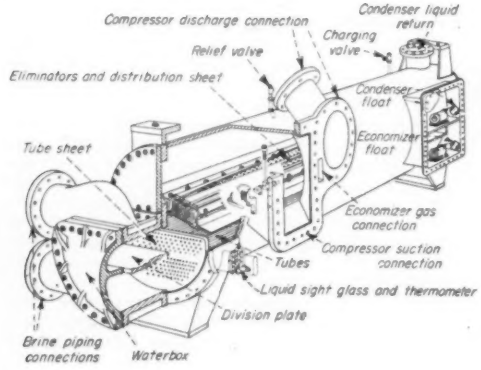
Know Your Centrifugal Compressors



CENTRIFUGAL REFRIGERATION SYSTEMS

These compact assemblies have seven major components. They operate like this: Refrigerant liquid from float chamber flows to cooler. There it surrounds tubes through which warmer brine or other fluid flows. Heat transferred from brine to refrigerant evaporates refrigerant at temperature fixed by cooler pressure. Vapor is drawn to compressor suction, partly compressed in first stage, and joins gas stream from economizer (see facing page). Gas then goes to second stage for further compression and is discharged to the refrigerant condenser. In condenser, gas is changed to liquid, goes to float chamber.

For facts on how each component works see text, sketches.

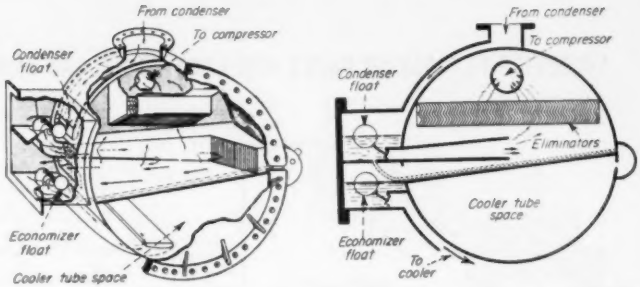


BRINE COOLER

Shell-and-tube flooded type; copper-finned tubes, cupronickel tube sheets. Other metals used; suit brine. Tubes rolled in, easy to remove. Normal refrigerant charge covers about 50% of tube bundle; in operation violent boiling of refrigerant covers bundle. Eliminators stop liquid carryover to compressor. Rupture valve, set at 15 psi for F-11, protects cooler. Waterbox covers removable, won't disturb other joints. Fittings: refrigerant thermometer, sight glass, charging valve, drain. Water circuit has vent and drain. Also, see economizer, p 115.

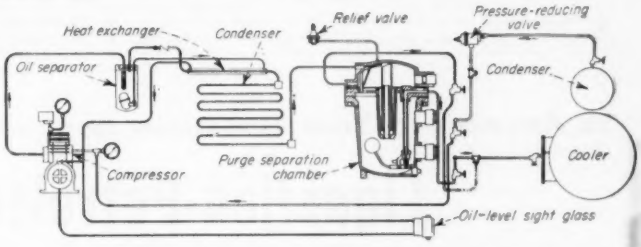
REFRIGERANT ECONOMIZER

Raises capacity, saves power. Partly cools liquid by partial evaporation before it goes to cooler. Vapor formed passes to 2nd stage of 2-stage units. Economizer-chamber pressure is about halfway between condensing and evaporating pressures in 2-stage units; warm liquid flashes, cools remainder. Flash vapor goes to compressor, joins 1st-stage discharge. Cool liquid goes to economizer float chamber.



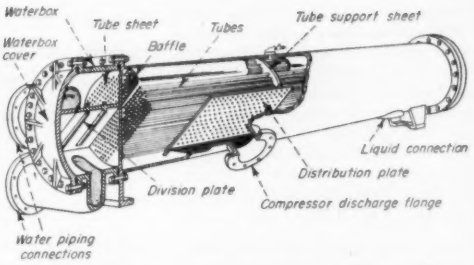
PURGE SYSTEM

Evacuates noncondensable gases, air and water vapor from condenser, recovers and returns refrigerant to cooler. Air purged automatically to atmosphere. Unit insures highest efficiency. Mixture from condenser compressed to about 80 psi by small reciprocating compressor. Vapor, condensed in air-cooled condenser, flows to evacuator where air and water are separated from refrigerant.



REFRIGERANT CONDENSER

Same tubes and sheets as cooler; others used if needed. Tubes supported in two intermediate sheets between end ones. Top portion of condenser baffled; collects, concentrates noncondensable gases; purge-recovery system removes them. Another tube-bundle baffle spreads compressor discharge lengthwise along bundle. Expansion joints used between cooler, condenser, compressor. Water circuit has vent and drain.



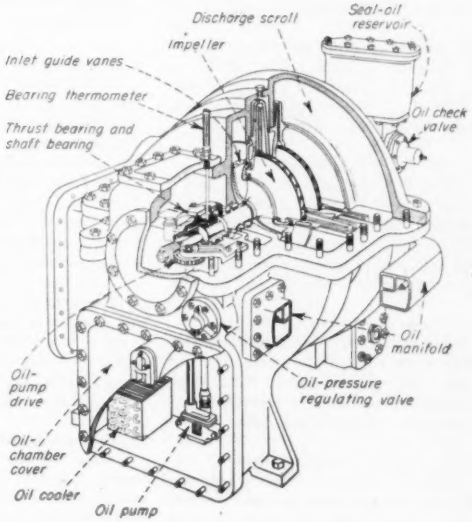
CENTRIFUGAL COMPRESSOR

Two- or three-stage units, depending on job. Each compressor is designed for specific refrigerant, like Freon-11. Others are used, too, but require design changes from standard.

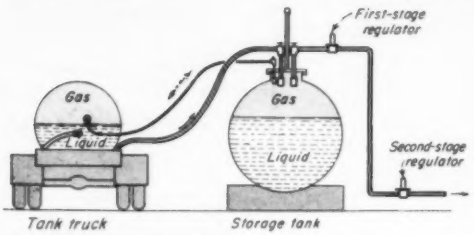
Easiest way to understand centrifugal-compressor operation is to think of a centrifugal fan—as often used for forced and induced draft. Like the fan, compressor takes in gas at end, whirls it at high speed. High velocity of gas leaving impeller is converted to pressure greater than inlet. At normal speed, with F-11, suction temperature is 65 F below condensation temperature for some units, 95 F for others. Changing speed varies suction temperature.

Two-stage compressor is shown. Seal at drive end prevents air leaking in, and refrigerant out. Kingsbury thrust bearing takes axial thrust. Gear pump supplies lube oil.

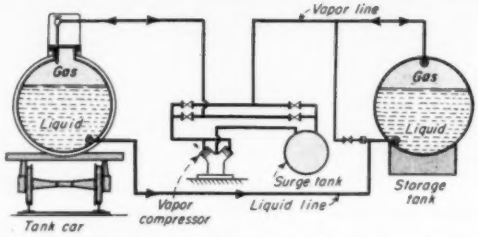
Continued on page 172



LIQUEFIED-PETROLEUM FUELS ARE EASY TO UNLOAD FROM TANK TRUCKS AND TANK CARS



1 **TANK-TRUCK** deliveries often use truck pump or one near storage tanks. Vapor connection between tanks is needed



2 **TANK-CAR** deliveries used for large industrial plants. Vapor-compressor transfer method, widely used, is safe and fast

18 Answers to Your Questions on

Liquefied-Petroleum Fuel Gases

Suitable for a variety of industrial jobs, these fuels are rapidly finding favor in all parts of the country. Learn what they are, where they're used, and how to apply them in your plant. This summary gives data from a number of sources

1 What are liquefied-petroleum fuels?
Propane and butane; they may be a single gas or a mixture of several. Lighter and easier to vaporize than gasoline, they are gases at ordinary atmospheric temperature and pressure. But when pressure is increased they liquefy readily. So it's easy to burn, store and transport them. Liquefied-petroleum gas fuels, LPG for short, have many trade names.

2 What's the source of LPG fuels?
Actively-producing oil and natural-gas wells are main source, but some is obtained in oil-refining operations.

3 How do propane and butane differ?
Propane, a little lighter, gasifies at a lower temperature, has lower heat value than butane. Table, facing page, summarizes important properties.

4 Do LPG properties affect use?
Yes. Propane boils at –44 F so it's used in cold climates. Butane boils at about 32 F, is used in warmer regions. Often mixture properties are adjusted for season of year; more propane is put in a mixture in winter than in summer.

5 Is heat needed to gasify fuels?
Yes, latent heat of vaporization. This heat must come from liquid itself or from some outside source. Study each installation to see if a controlled, external heat source is needed.

6 What heat sources are used?
External steam, hot-water, or gas-burning heaters may be used. Vaporizers, Fig. 3, are of various designs. Fired units, direct or indirect, used too.

7 What are industrial uses of LPG?
These fuels are used for boiler firing, heat-treating furnaces, incinerators, direct-flame sterilizing, space heating and many other jobs.

8 How is LPG transported?
High-pressure tank cars and trucks carry bulk shipments, also a few tankers. ICC approved cylinders, 20-300 lb, are often used for smaller shipments, like those between bulk plant and industrial user. Tank cars hold 8000 to 12,000 gal, tank trucks 550 to 8500 gal. Pipelines also used to transport gas from producing area to large bulk-storage farms.

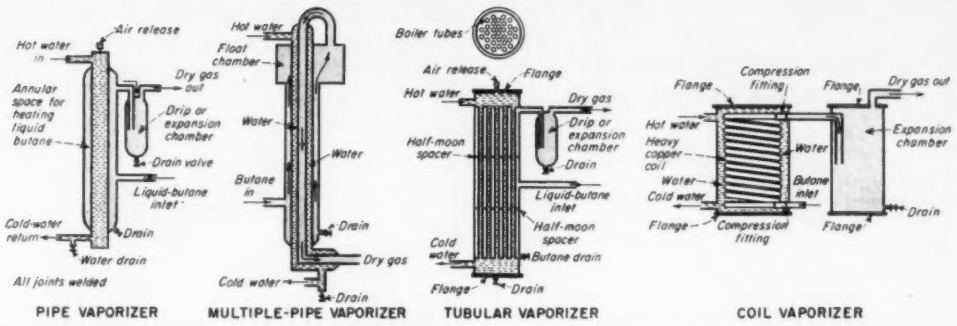
9 How is LPG transferred from tank car or truck to storage tank?
Three main methods are: (1) gravity (2) pump and (3) vapor compressor. In each, LPG fuel is received in liquid form and transferred that way.

10 How do transfer methods work?
Gravity system uses difference in height between delivery and storage tanks to produce flow. Pipe connects vapor spaces of tanks so flow is possible. Method is slow and undesirable.

Most tank trucks are fitted with a pump for transferring fuel to storage tank, Fig. 1. Or pump may be installed near storage tank. Equalizing vapor connection between tanks is needed.

Vapor-compressor method is often used. Instead of pumping liquid into storage tank, vapor is pumped into tank car, Fig. 2. This forces liquid from tank car to storage. Equipment arranged to pump vapor in opposite direction, too. After liquid is transferred, vapor in tank car is pumped to storage tank. In extremely cold weather compressed air may have to be supplied delivery tank. Use thoroughly dry air to prevent entrance of moisture into tank.

11 Do LPGs need special valves, fittings in transfer and other pipes?
Propane and butane are "sweet" gases having almost no sulfur content; they are relatively noncorrosive. They have solvent action on rubber and only appropriate valve-seat and gasket material should be used. Pipe compounds safe from solvent action must also be used. Experienced designers are needed for system layout and planning. Submit all designs to proper authorities for approval before starting construction.



3 **VAPORIZERS** turn liquefied petroleum to gas for safe transmission to various parts of plant.. Vaporizers must be designed and constructed for safety, so homemade units cannot be used. Consult safety recommendations for details

PROPERTIES OF LIQUEFIED PETROLEUM FUELS

	Propane	Normal Butane
Specific gravity of liquid at 60 F; water = 1.00	0.509	0.584
Vapor pressure, psig		
At 60 F	92	12
At 100 F	172	37
Wt per gal of liquid at 60 F, lb	4.24	4.86
Boiling temp of liquid at atmospheric pressure, F	—44	32
Cu ft of gas (60 F, atmospheric pressure) per lb liquid	8.59	6.51
Cu ft of gas (60 F, atmospheric pressure) per gal liquid	36.5	31.8
Specific gravity of gas; air = 1.00	1.52	2.00
Range of flammability of gas in air, % gas in air-gas mixture	2.4 to 9.5	1.8 to 8.4
Btu per lb gas	21,600	21,300
Btu per cu ft gas at 60 F, atmospheric pressure	2520	3270

12 Is LPG always used undiluted as it evaporates from the liquid?

Gas may be used without dilution at its normal Btu value or diluted with air at lower Btu values. When diluted with air, amount used for dilution is always outside range of flammability, more gas being present than would form an explosive mixture.

13 Is any gas burner suitable?

Since a gas burner supplies a given amount of gas mixed with chosen amounts of air, any burner suitably adjustable for supply of proper air-gas mixture can be used. In addition, burner must be suited to existing furnace conditions. There are a variety of burners designed for LPG and their use is desirable. Adaptation of a burner for one gas to another, or one with a different heating value, should be done only by an experienced burner man. Whether it can be done satisfactorily depends upon burner.

14 How is LPG stored?

Tanks above and below ground are used; also portable tanks. All tanks must be designed for the working pressure to be used. National Fire Protection Assn with cooperation of insurance and other industrial agencies has developed recommended practices for design, construction and installation of storage tanks. Insurance companies have adopted these recommendations. Publications of some of these firms are listed at end of article.

15 What accessories are used on LPG storage tanks in industrial plants?

Liquid-level gages, a pressure gage, shutoff valves, safety-relief valves, excess-flow valves and backpressure check valves.

16 Do LPGs have distinct odors?

No. They are practically odorless unless an artificial odor has been put in the gas. Always check to see that gas you purchase has been artificially odorized. Also check from time to time to see that odor strength hasn't decreased markedly. Most states require warning stench in LPG.

17 What properties of LPGs must be understood for safe handling and use?

Briefly, these: *Gases* are heavier than air; gases won't diffuse rapidly into atmosphere unless air velocity is high; air-gas mixtures readily ignitable in flammable range; mix with inert gases like nitrogen, carbon dioxide, steam or air to bring below flammable limit; using fine water spray reduces probability of ignition; vapor pressure is greater than gasoline at same temperature; closed pressure vessels built to regulations and fitted with required safety devices are only safe storage place; liquids expand in storage tank with increase in temperature so tanks shouldn't be filled with liquid to top.

18 What happens to LPGs when released at normal atmospheric temperature and pressure?

You can expect that: liquids will vaporize readily though atmospheric temperature is below liquid boiling point; liquid may remain in fluid state for relatively long period if volume is sufficient even though exposed to summer heat; liquids discharged from leaks in pipes or tanks must absorb heat from surroundings to gasify, so use recommended dikes or ditches to confine or divert liquid flow; flammable air-gas mixtures exist above surface of released liquids; flammable-vapor indicators give quick check on presence of leaks; rapid removal of vapor from tank reduces liquid temperature and tank pressure, but rapid removal of liquid by normal means doesn't reduce tank pressure; liquid from storage tank may freeze hands on contact; explosive ranges are generally narrower than for other fuel gases.

EDITOR'S NOTE: Publications helpful in industrial use of LPG are: *Liquefied Petroleum Gases*, NBFU Pamphlet No. 58, *Recommended Good Practice for Storage and Handling of Liquefied Petroleum Fuel Gases*, Factory Insurance Assn, Hartford 2, Conn.; U.S. Dept. of Interior Circular I.C. 7519, *Questions and Answers on Propane and Butane Fuels*. There are many others.

OIL IS STEPPING ASIDE TO MAKE ROOM FOR AIR UNITS

Three manufacturers have built ocb's with an interrupting rating of 10,000,000 kva at 230 kv. These particular units will handle the eighteen 108,000-kva generators and twelve 65,000-hp synchronous-motor pumps, ultimately to be connected to a solid bus at Grand Coulee Dam.

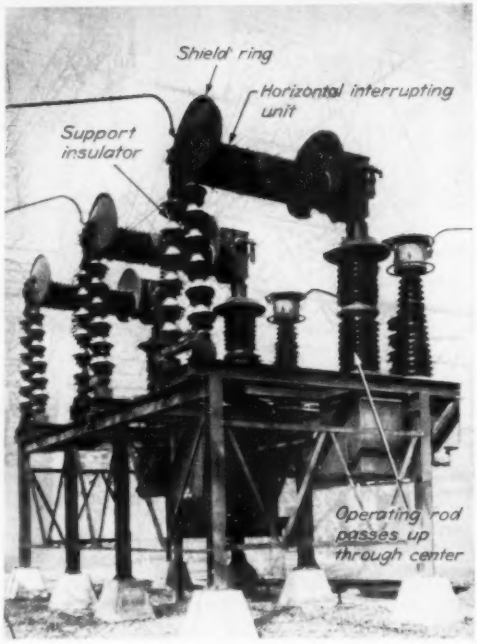
In Europe most major power installations use high-power compressed-air circuit breakers. Those for the newly proposed Swedish 380-kv system will have an interrupting rating of 8,000,000 kva at 380 kv. The Electric of France has compressed-air circuit breakers rated with a 6,500,000-kva interrupting capacity at 230 kva.

Air breakers are used in Europe mainly because of economic necessity. On this side of the Atlantic, air breakers have gained wide favor for voltages up to 34.5 kv.

The European axial-blast breaker has apparently set the style pattern. It is believed this latter breaker will surpass even the cross-blast breaker in time. In the near future, voltage and kva ratings of the axial-blast breaker will be extended to the highest transmission voltages.

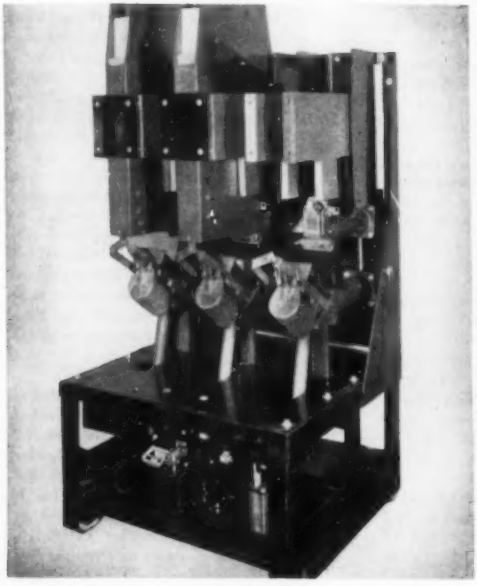
It is further believed the axial-blast breaker will crowd out all the oil-type units in the distant future. But the high-power, supervoltage high-speed ocb will keep out in front for some years to come.

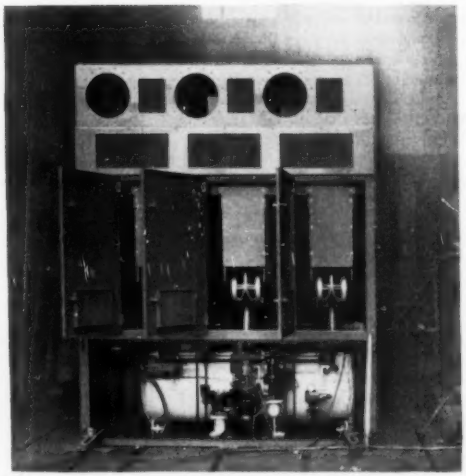
CONSTRUCTION FOR LOW-OIL CONTENT . . .



1 Oil-blast breaker for 230-kv application at Grand Coulee. This 3-pole 3-cycle unit interrupted 6750 mva on field test

COMPRESSED AIR IS THE OPERATING MEDIUM IN THESE CIRCUIT BREAKERS





5 Compressed-air breaker setup for the manufacturer's test. This 3-pole 4000-amp unit operates on 150-psi air pressure

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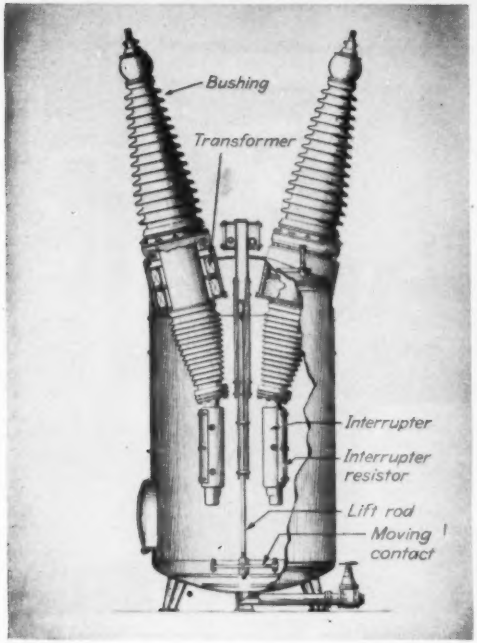
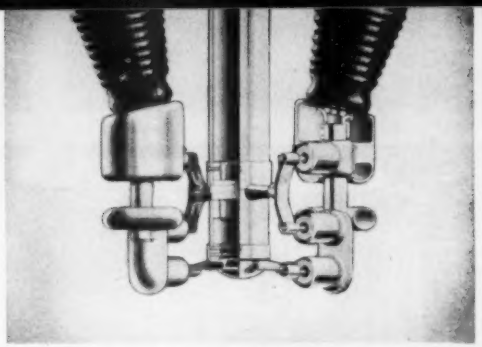
6 Magnetic air breaker rated 500 mva at 15 kv. One arc chute is removed showing contacts, magnetic pole-pieces

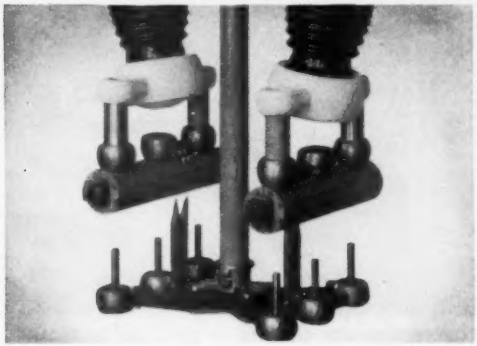
. . . AND STANDARD-TANK OIL-BLAST BREAKERS



2 Cross-section of a 3-cycle 230-kv 3500-mva oil-blast tank-type breaker. Each 2870-gal tank is 84 in. diameter



3 Phantom view of 230-kv 1200-amp unit with 10,000-mva interrupting capacity; bushing current transformers used



4 Internal view of one type ocb with contact bar in the open position. Note that there are six breaks in series per pole

High-Power Circuit Breakers...Today

Interrupting capacity is being upped while oil content of ocb's decreases. Use of compressed air is increasing

By R H NAU, *University of Illinois*

► OIL CIRCUIT BREAKERS were almost universally used, until recently, for all ac circuits above 550 volts. The picture has been changed somewhat during the past few years by the introduction of the oilless or air power-breakers for indoor work. Likewise, the air breaker is being used for high-voltage out-of-door application.

Oil Circuit Breakers. There are two methods for deionizing the conducting arc stream between two immersed contacts: *multiflow* and *oil-blast*. And the interrupting principle remains the same whether unit is encased in conventional dead-tank structure or in a low oil-content enclosure.

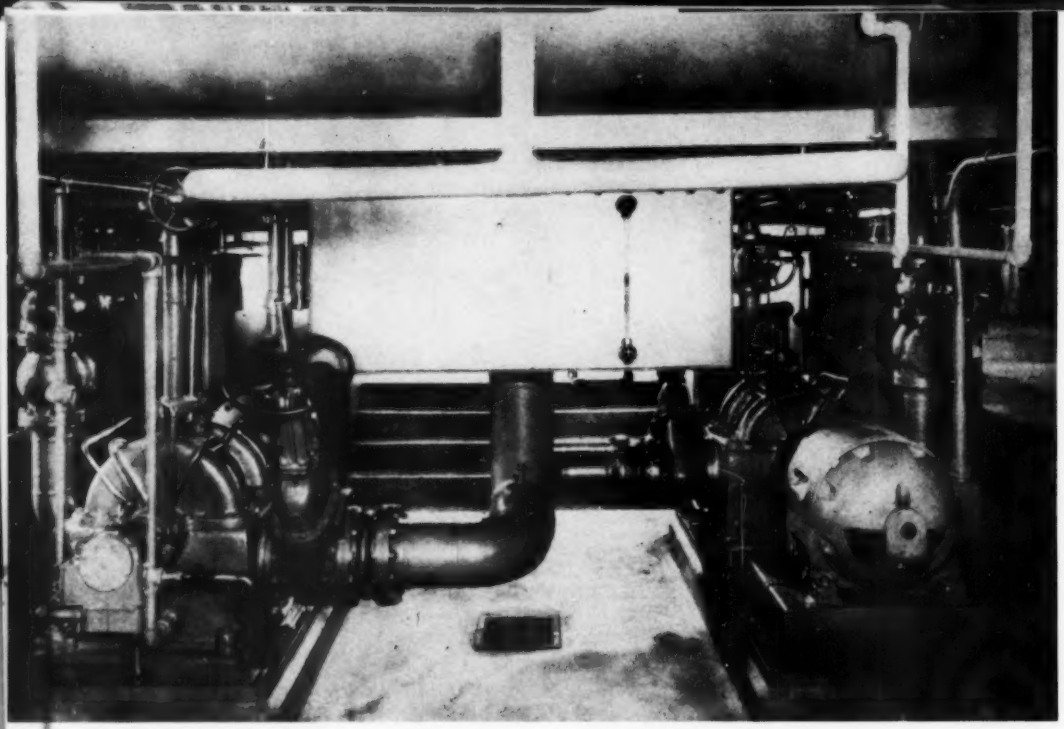
Oil-blast principle stems from the action of a large pneumatically operated piston. Recently developed breaker in this class, Fig. 1, has five distinct series breaks per pole. Oil flow, started by the impulse piston, blasts the arc against the fiber jacket.

Interrupters in one type of *multiflow* unit are essentially grids of various-shaped punchings of ¼- and ⅜-in. fiber. High-speed contacts are then fitted inside the above grids introducing two breaks per grid unit on opening. Oil is driven through many small openings, directed radially into the arc-stream.

Air Breakers. Progressive inroads are being made into the fields calling for high-power applications at generation, utilization and sub-transmission voltage. This may be attributed to elimination of oil messiness and fire hazard.

Two types of air breakers for modern metalclad switchgear are *magnetic*, Fig. 6, and *compressed-air* unit, Fig. 5. Magnetic breakers have a strong transverse magnetic field from the short-circuit current shunted through a multi-turn coil. They're well fitted for 2.5- to 15-kv range with interrupting ratings to 500,000 kva.

In the compressed-air field we find the *cross-blast* and *axial-blast* breakers. In the former, an intense cross air blast holds the arc in shallow V-slots of thick fiber. They are often applied in the 15-kv 2,500,000-kva range. But in the *axial-blast* compressed-air breaker the arc is met with an axial blast of air, essential difference being direction of the compressed-air stream. Breakers are available in this type to handle short-circuits over 3,500,000 kva at 138 kv.



CONDENSATE-PUMP CONTROL. In the several arrangements possible for controlling condensate-pump discharge and condenser hotwell level, the combination and location of the control depends largely on plant heat cycle, equipment layout

Throttle Control Regulates Condenser Hotwell Level

For good condensate pump operation, hotwell liquid level must be held within close limits. Here you learn how to do this by throttle control of pump discharge, how to select right size valve for the job, how to regulate bypass valve several ways

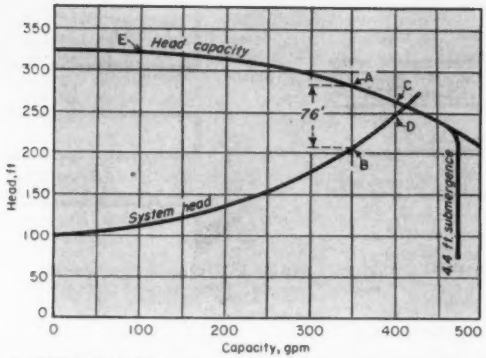
By PIO NARDONE
Mechanical Engineer, Condenser Div
Foster-Wheeler Corporation

► CENTRIFUGAL PUMPS are generally used to remove condensate from steam-turbine condenser hotwells. Because of load changes on the turbine, discharge of these pumps must be adjusted to hold hotwell-liquid level within safe operating limits. For this, there are three basic types of control: submergence, recirculation and throttle. We will consider throttle control here.

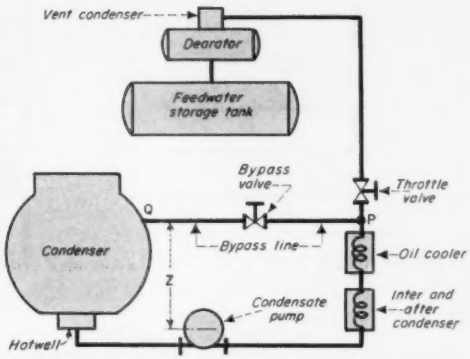
This type of control is obtained by throttling pump discharge so water pumped into the system always equals that flowing into the hotwell from the condenser. Difference between pump head-capacity curve and the system head at a given gpm is lost in the throttle valve. For example, in Fig. 1, at 350 gpm the pump develops 283-ft head, point *A*. At this flow the system head is about 207 ft, point *B*. Difference between the two heads, $283 - 207 = 76$ ft, must be dissipated in the throttle valve, Fig. 2.

Throttle Valve. This valve is selected for the design gpm and permissible head drop. The latter is the difference between the design pump head and the system head at design flow, usually a few pounds. In Fig. 1, design flow would be taken at 400 gpm, at which the pump develops 265-ft head, point *C*. The system head at this flow is 247 ft, point *D*, a difference of $265 - 247 = 18$ ft. The throttle valve would, therefore, be selected for 400 gpm and a maximum head loss of 18 ft. This would permit using a 5-in. valve, which requires only a 9-ft differential with this flow.

As with recirculation control, Feb. POWER, p 75, a float-operated valve, controlled by changes in hotwell level, is generally used. This valve may be directly operated by a float or be pilot-



1 THROTTLE VALVE. This valve is selected for pump's designed discharge and the permissible head drop across the valve



2 VALVES' LOCATION. Locate throttle and bypass valves after air ejector and units through which condensate goes

actuated by air pressure. The pilot is arranged to increase air pressure on the valve to close it against a spring as hotwell level drops. This insures that the valve will open if the controller fails, and that water will keep flowing into the system. If this happens the pump may revert to submergence control, but the turbine remains in operation.

Bypass Valve. At light loads and during starting a means is required to insure a minimum flow of condensate. This is needed for the condensate pump and the air-ejector condenser and other coolers, if any.

Throttle control combined with a bypass is perhaps the most desirable method of the three for most applications. The bypass may be controlled by: (1) hand (2) temperature rise across air ejector (3) outlet temperature of air ejector (4) flowmeter in the system (5) hotwell-liquid level.

Bypass Control. In all these arrangements, throttling as controlled by hotwell level operates from maximum to minimum load on the turbine. A manually operated valve, opened at a predetermined load to maintain the desired minimum recirculation, is the simplest method of controlling the bypass. If desired, bypass can be left open. At loads above which recirculation is required, leaving bypass open operates pump at a higher flow than necessary. Automatic methods of controlling bypass are increasing.

One method automatically controls the bypass valve by the condensate temperature rise across the air ejector. As turbine load decreases, less condensate goes through air-ejector condenser, and condensate temperature rises.

Condensate temperature continues to rise until maximum permissible temperature or minimum condensate flow is reached. At this point, the bypass valve starts to open to hold condensate's temperature down to maximum permissible value and hold the pump discharge up to minimum flow.

As load continues to drop, the bypass valve opens until it is full open at minimum load on the turbine. The valve is selected for desired minimum-load flow. The head available across the valve is the head developed by the pump at this flow, less the static and friction losses as described for the recirculation control valve, Feb. POWER, p 77.

For example, in Fig. 1, at desired minimum flow of 100 gpm the pump develops 323-ft head, point *E*. Pipe-friction head loss from the pump to *P* is, say, 2 ft, Fig. 2. Friction head loss in the recirculation line from *P* to *Q*, outside the valve, is 15 ft. Static height Z from pump datum to the bypass line is 10 ft. Then, head available across the valve is $323 - (2 + 15 + 10) = 296$ ft. The bypass valve will be selected for 296-ft head loss across it at 100 gpm.

Note the difference in selecting a bypass for recirculation and for throttle control. For recirculation control, the bypass valve is chosen for full capacity of the condensate pump at a comparatively low head loss across the valve, Feb. POWER, p 77. For throttle control, the bypass valve is selected for desired minimum flow and a comparatively high head, as above.

Bypass valve may be positioned only by outlet temperature of the condensate from the air-ejector condenser. This in general is not as satisfactory as temperature-rise control because outlet temperature varies with inlet temperature as well as with flow.

Open and Closed Valve. A third method of control fully opens or closes a bypass valve. This valve may be solenoid operated and controlled by a flowmeter connected in the system after the throttle valve. When the flow falls below a selected minimum the valve opens, and closes when the flow increases above a certain amount.

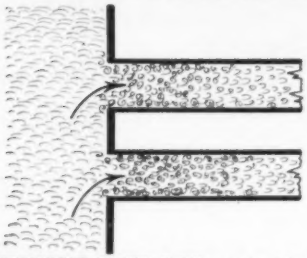
Control of both throttle and bypass valves by hotwell level is gaining popularity. Until the hotwell level falls to a selected point, only the throttle valve operates, the bypass valve remaining closed. As the hotwell level falls below the chosen minimum the throttle valve continues to close and the bypass begins opening. As long as the level remains below the selected minimum, a single-lever controller operates both valves.

Valve Locations. In any condensate-flow control system that has a throttle and a bypass valve both are located after the air-ejector condenser and other units through which minimum condensate flow must pass. The bypass line is placed just ahead of the throttle valve, as in Fig. 2.

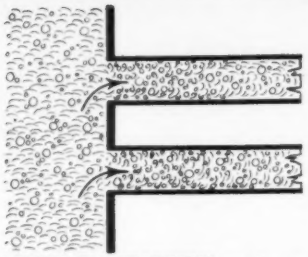
The methods described and others for controlling condensate bypass flow have their advantages and objections. Method selected should be the one best suited to a given installation. Methods described indicate the various controls that can be used and emphasize that a bypass connection is needed during light loads and starting periods.

Of the three basic forms of control for condensate pumps, throttle with some type of bypass is generally the best. It is the most economical when considering power consumption, minimum heat loss and equipment life. Its operation is smooth and positive when properly selected and installed.

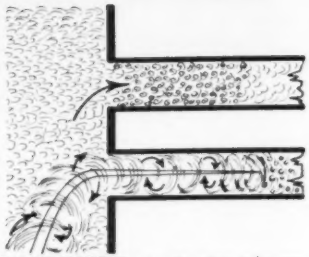
WATER FLOW BEHAVIOR THROUGH TUBES CONTROLS NATURE OF DESTRUCTIVE ACTION



TURBULENT WATER FLOW at tube inlet causes local erosion-corrosion attack



AIR-BUBBLE ENTRAINMENT accelerates rate of tube erosion-corrosion effects



WATER VORTEX extending into tube carries air, forms bubbles aiding erosion

Alloys and Design Fight Condenser Ills

Wilson Lynes, Revere Copper and Brass Inc, tells how power-plant steam condensers grew. Since their first application they have undergone steady improvement in materials, design and operation to meet problems of water, steam and air flow

► JAMES WATT'S PATENT of 1769 on steam-engine improvements included a vessel, separated from the cylinder, for condensing steam. He also had a pump for removing noncondensable gases. Watt's first experimental condenser was a surface type, but in practice he used jet condensation.

First use of surface condensers, until 1837, was for experimental purposes only. In that year one unit, designed by Samuel Hall, was installed in the paddle-wheel steamship *Wilberforce*. Vertical, longitudinally brazed copper tubes were used. Steam passed inside the tubes. Prior to 1860, condensers with horizontal copper tubes were in use, in which steam passed on outside.

Seamless copper tubes became available about 1860, but they were gradually superseded by brass. The British Admiralty specified 70-30 brass in 1870. About 1890, admiralty brass came into use. It was an improvement because of its greater resistance to the dezincification form of corrosion.

Steam turbine application early in the 20th century caused condenser design changes that had marked effects on condenser-tube performance. This led to development of alloys having more resistance to the new conditions. Improvement of condenser vacuum received much attention because the steam turbine gained more from lower backpressure than the engine.

Condenser vacuum was improved by reducing air leakage and improving air-ejection techniques. This caused a lower rate of condensation because of the lower mean temperature difference between steam and cooling water. Since high vacuum depends on a high rate of steam condensation, efforts were made to improve the total heat-transfer rate. This was done by (1) better steam, air and water flow (2) chlorination and tube cleaning (3) increased velocity of cooling water.

High temperature and low water velocity accelerate dezincification of brass. Changing conditions caused by use of the steam turbine reduced the frequency and severity of this form of trouble. But the higher water velocity and decreased dezincification rate brought tube failures of the erosion-corrosion form into prominence. This resulted in increased tube deterioration with the tube alloys available at that time.

Increasing troubles with brass tubes led to many investigations of the cause and prevention of corrosion. Much credit is due to the research of Bengough and May for the Corrosion Committee of the Institute of Metals, formed in 1910.

Improved Alloys. The first World War emphasized need for fully reliable condenser tubes. Possibility of tube failure had been of great concern to the navies of all countries. Shortly after the war, 80-20 and 70-30 cupronickel became available. Because of outstanding erosion and corrosion resistance of 70-30 cupronickel in sea water, it became standard in the American and British Navies.

There still remained a large field of usefulness for admiralty brass, especially since improvement was made by a slight modification of its composition. In 1922, Bengough and May reported that addition of a few hundredths of one percent of arsenic was remarkably effective in suppressing dezincification. In a few years this discovery was put into practice. Later it was found that antimony and phosphorus performed the same function.

In 1928, May published results of water-air bubble impingement tests showing that the protective film formed on aluminum brass was strongly resistant to erosion by high-velocity aerated sea water. This alloy has since been widely used under conditions of corrosion and erosion too severe for admiralty. Early addition of arsenic to aluminum brass to inhibit dezincification was an important factor in its success.

Aluminum bronze had erosion-resistant properties similar to aluminum brass but in many waters had greater tendency to pit at low velocities than the latter alloy.

In 1939 it was reported that adding about 0.5% iron to 70-30 cupronickel improved its resistance to erosion-corrosion (impingement) attack.

Recently it has been found that a low nickel-high iron cupronickel (for example, 10 nickel—1 iron) has properties comparable to 70-30 cupronickel and is less costly.

Further improvement in condenser-tube alloys will surely be made. Active work on the subject is in progress both here and in England.

At present condenser-tube corrosion is reasonably under control except for (1) rapid pitting attack with badly polluted waters, and (2) still too high a percentage of failures from erosion-corrosion (impingement) attack with brackish- and sea-water cooling. More resistant alloys are needed for waters polluted by bacterial decomposition of organic material. Much work is being done on this difficult problem as well as on production of more erosion-resistant alloys for condenser tubes.

Condenser-System Hydraulics

When records of tube failures from erosion-corrosion are plotted on a plan of the tube plate, they are often found to group closely over one or more areas. Rest of the tubes have no failures. Replacing the damaged tubes shows that failures again occur in the same areas. Hydraulics of the condenser system is the key to the observed facts. If the local water-air flow conditions causing local attack could be properly changed, admiralty would be satisfactory in many condensers where a more expensive alloy is now needed. Again in other cases, the more expensive alloys would perform satisfactorily where they do not now.

Causes. When considering condenser-system hydraulics in relation to tube deterioration, the principal points are: (1) turbulent water flow favors erosion-corrosion, "large" air bubbles (those that break into smaller bubbles on contact with the tube wall) accelerate tube damage (2) nonuniform velocity produces turbulent flow, the two being proportional (3) increase in water velocity causes decrease in pressure (4) decrease in water pressure releases air from solution as bubbles* (5) center of a free vortex is a low-pressure region in which a "ribbon" of air usually forms (6) free air enters the system where water pressure is less than atmospheric if there are leaks in those areas.

In a condenser siphonic system with both legs at the same elevation, the static pressure at inlet ends of the top row of tubes is determined by their elevation above the tide level. The dynamic pressure at this location is fixed by velocity and turbulence of the water flow and frictional resistance with the tubes. Under hydrodynamic conditions, local deviations in pressure and velocity are determined by design of the condenser system. Degree of turbulence in the waterbox and at tube inlets is determined by pressure-velocity pattern of the condenser water-flow system.

Favorable Features. Turbulence reduction in the inlet waterbox and the tube inlets is favored by (1) decreasing ratio of pump capacity:area of inlet nozzle (2) increasing ratio of pump capacity:pump speed (3) decreasing ratio of pump capacity:waterbox volume (4) decreasing angular change in direction of water from pump to tube sheet.

The waterbox inlet nozzle should be gradually enlarged to avoid turbulence produced by sudden enlargement of the water stream. Tube inlets should be rounded to avoid forming *vena contracta* caused by sharp entry. Inner surfaces of the waterbox should be smooth. Internal reinforcements and recesses formed by inspection doors will create local high velocities.

Vortex Influence. Vortexes have been observed in inlet waterboxes fitted with glass observation windows. Vortexes are especially objectionable because their centers are usually air filled. When a vortex enters a tube the mass of air impinges on the tube wall in the form of bubbles where random turbulence replaces helical flow. A free vortex entering a tube with sufficient radial velocity causes cavitation.

C A Parsons observed this in an experimental condenser having a water velocity of 8 ft per sec at the waterbox inlet and in the tubes. When the vortex was drawn into the mouth of the tube he saw that the flow in the tube was partially arrested. The discharge was reduced in a fraction of a second to about one-fifth of its previous rate. Vacuum at the core of the vortex was momentarily intensified by arrest of momentum of water already in the tube. A vacuous thread extended momentarily into the tube for about 18 in. and then collapsed irregularly at various points.

Vortex formation in the waterbox is favored by (1) entry of water into waterbox tangentially (2) high entrance velocity (3) shallow waterbox. It has been prevented by installation of guide vanes in the waterbox.

Variation in pressure with elevation in the waterbox is another source of turbulence and air release. In a well-vented box this would cause higher water velocities through the upper tubes. In a badly vented box air pressure at the top causes water surges. Air discharges periodically through the upper tubes. Using top-row tubes as air vents presumably has bad effects on their life.

It seems that *average* water velocity in the tubes calculated from pump capacity gives an inadequate picture of true velocity in individual tubes. Cases have been observed where water in some tubes flowed toward the inlet waterbox. Similarly, total air in the water entering the tubes distributes through them in a markedly nonuniform manner, and in a wide range of bubble diameters. The water-air flow pattern may vary greatly from one condenser to another.

Amount of free air entering the waterbox may be augmented considerably when a vortex forms in the suction pipe of a centrifugal pump. This may be prevented by guide vanes in the suction line.

Air Leakage. In addition to releasing air from solution, air may leak into the condenser at (1) suction bell if submergence is shallow enough to create a vortex around it (2) pump packing if it is not water sealed at or above atmospheric pressure (3) leaks in piping (4) inspection doors with defective gaskets or warped edges.

Design Improvements. Condenser design practice appears to have paid more attention to heat-transfer rate improvement than to bettering the hydraulic system performance. Advantage of ample depth in the waterbox has been known for years, but has not been carried far enough in usual practice. Reduction in waterbox inlet velocity does not seem to have received much attention.

W R Morgan advocated a wedge-shaped box to minimize pressure drop. He believed that improved hydraulic conditions, reflected in fewer tube failures would result from wide tube spacing instead of close spacing with wide intervening steam lanes.

One condenser design has inlet waterbox divided horizontally into four compartments with side admission of water from twin nozzles at bottom of the box. Flow conditions at the tube inlets were said to have been improved in comparison with usual practice.

A J German said that waterbox design of a 2-pass condenser, ideal from a circulating-system point of view, would comprise (1) an inlet box without division plate (2) streamlined entrance to first pass ending in same direction as water flow through the tubes (3) properly curved reverse-flow waterbox (4) interiors of both boxes free from reinforcements or recesses.

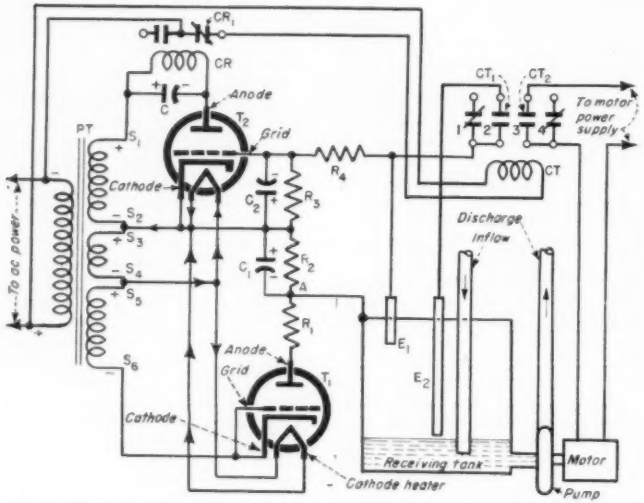
For any water supply, the hydraulics of the condenser system and composition of the tubes are the only important variables affecting tube life that can be altered. This assumes the tubes are free from obstructions. We have emphasized the importance of intensive work on improving tube alloys and flow conditions.

* "Air" bubbles, released from solution on pressure reduction, may have a composition quite different from true air.

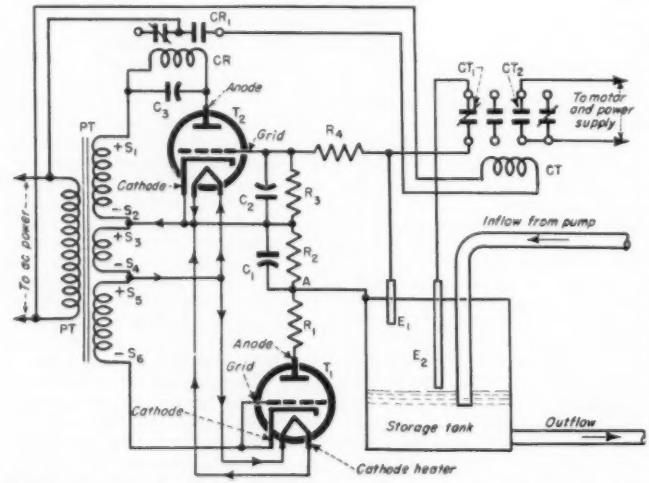
ELECTRONICS FOR THE POWER ENGINEER

By F A ANNETT, *Associate Editor*

35—Liquid-Level and Pump Controls



1 System of liquid-level control for emptying a tank. When liquid rises and contacts electrode E_1, pump starts and runs until liquid level falls below E_2, then stops



2 Same control as Fig. 1, but arranged to keep the tank full. When liquid level rises and contacts electrode E_1, the pump stops until liquid falls below E_2, then starts

► ELECTRONIC RELAYS are used in several ways as floatless level indicators on storage tanks and in operating pumps to empty or fill tanks. They are also applied to control boiler-feed level and in other ways. Here we will study electronic control to empty a tank, to fill a tank, and a pump sequence-control system.

Liquid-Level Control. Fig. 1 diagrams a General Electric system of liquid-level control. High and low liquid levels are controlled by two probes or electrodes, E_1 and E_2, that contact the liquid. When the tank fills and contacts electrode E_1, the pump is started to empty the tank. As the liquid level drops and breaks contact with electrode E_2 the pump stops.

Secondaries of transformer PT supply the energy to heat the cathodes of rectifying tube T_1 and amplifying tube T_2, to operate relay CR and contactors CT. When the transformer has the polarity indicated, current flows from S_4 through the cathode heaters and back to S_3. When the water level drops to clear electrode E_1, minus bias is removed from tube T_2 and it conducts. Under this condition tube T_1 conducts from S_4 through R_1 and R_2 to S_3, back to S_6.

Cathode of T_2 connects to the lower end of R_3 and its grid to the top end. Since no current flows through this resistor there is no voltage drop across it, and cathode and grid are at the same potential. Tube T_2 conducts from S_2 through relay coil CR to hold contact CR_1 open and break the circuit through contactor coil CT. Contacts CT_1 and CT_2 stay open to stop the pump.

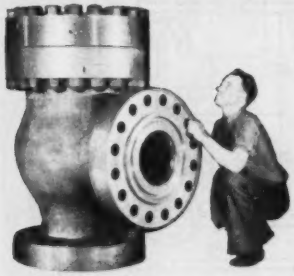
Liquid Rises. When the liquid rises and contacts electrode E_2, it has no effect because this electrode is disconnected through contact CT_1. The liquid can rise until it contacts electrode E_1. When this happens a minus bias is applied to the grid of T_2. This bias is from S_4, through T_1, resistor R_1 to the tank, through the liquid to electrode E_1, resistor R_4 to the grid, and cathode of T_2 to S_2 and to S_3.

This bias blocks tube T_2 and drops out relay CR. Contact CR_1 closes to complete a circuit from — power line

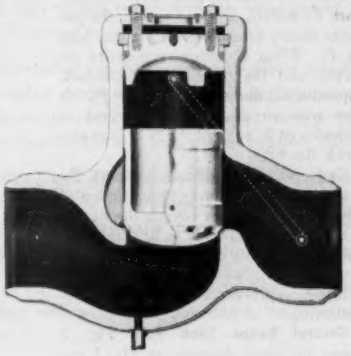
PIPING FLEXIBILITY *with* Edward *Check Valves*

FOR large, medium or small lines . . . for horizontal, vertical or angle installations . . . for 150 lb to 7500 lb service . . . stainless steel or Stellite trim . . . whether you need flanged, screwed or welding ends—there is an Edward steel check valve to meet your requirements. Many sizes and types are in stock for immediate shipment.

BIG CHECKS

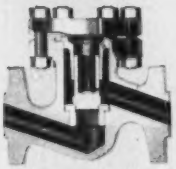


Vibration, clatter and damaging shock to piping are eliminated with Edward piston-type check valves. Integral guide ribs, cored out for free flow, guide the hourglass disk-piston throughout travel to prevent hanging up. New flow contours reduce pressure loss, increase operating efficiency. Built in sizes through 14 in.



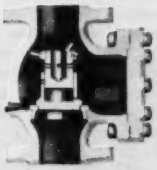
AVAILABLE IN HORIZONTAL ~ . . . ANGLE ⌜ . . . VERTICAL |

MEDIUM



Exclusive Edward disk guide lip aids tight seating and cuts wear on seat and disk through momentary throttling action.

Edward check valves may be disassembled without removing from the line. Covers are forged steel.



AVAILABLE IN HORIZONTAL ~ . . . ANGLE ⌜ . . . VERTICAL |

SMALL

Edward forged steel check valves are spring loaded to insure quick, accurate seating. Bodies are streamlined.

For viscous fluids or hydraulic service, Edward ball checks are ideal. Stainless steel ball is mated to seat.

Design of small Edward checks permits use in either horizontal or vertical lines. Built in sizes down to ¼ in.

AVAILABLE IN HORIZONTAL ~ . . . ANGLE ⌜ . . . VERTICAL |

Another Product

Edward Valves, Inc.

Subsidiary of ROCKWELL MANUFACTURING COMPANY

EAST CHICAGO, INDIANA

A REQUEST ON YOUR COMPANY LETTERHEAD WILL BRING EDWARD CATALOG No. 103

through contract CR_1, coil CT to the + power line. Contacts CT_1 and CT_2 close. Contact CT_2 starts the pump to empty the tank. When the liquid level drops and breaks contact with electrode E_1, bias is held on T_2 grid through electrode E_2, contact CT_1 being closed. Pump continues to run until the liquid breaks contact with E_2 to remove the bias from tube T_2 grid. Tube then conducts and relay contact CR_1 opens to stop the pump until the tank fills again.

Capacitors Hold Grid Bias. Capacitors C_1 and C_2 are charged to the polarity shown when there is a minus bias on T_2. When transformer polarity reverses, and the tubes cannot conduct, capacitor C_2 discharges through R_5. It also tries to discharge from grid to cathodes of T_2 to hold the grid bias and block the tube.

Capacitor C_1 discharges through R_3. It also tries to discharge to the tank and electrodes, when they contact the liquid, to the grid and cathode to hold the grid minus. Capacitor C discharges through the relay coil on reverse transformer polarity to prevent the relay's contacts chattering.

Control Keeps Tank Full. Fig. 2 shows the same diagram as Fig. 1 except that connections are arranged to keep the tank full instead of empty. Relay CR contact is changed from one that is normally closed to one normally open. Electrode E_2 is connected to normally closed contact CT_1 instead of one normally open.

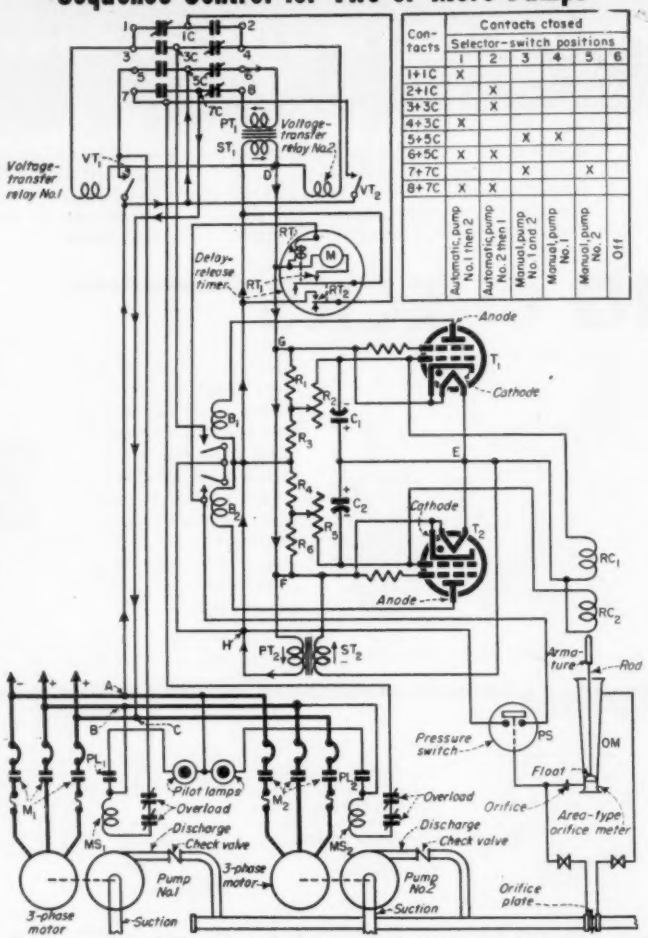
When the fluid drops below electrode E_2, minus bias is removed from tube T_2 and it conducts to close relay contact CR_1. This energizes contactor coil CT to close contact CT_2 and open contact CT_1. Closing contact CT_2 powers the pump motor to fill the tank.

Contact CT_1 disconnects electrode E_2. Thus when water rises and contacts it, a minus bias will not be applied to the grid of tube T_2 so relay CR remains closed. When the pump fills the tank, and water contacts electrode E_1, a minus bias is applied to grid of T_2. This bias is from S_2 through T_1 to A to the tank through the liquid to E_1, through R_4, the grid to cathode to S_2. Tube T_2 is blocked and relay CR drops out as does contactor CT.

When contactor CT opens, it closes contact CT_1 to connect electrode E_2 to the grid circuit. When the liquid drops away from electrode E_1, E_2 holds the bias on T_2. Relay CR and contactor CT remain deenergized until the liquid drops below E_2. When this happens the pump is again started.

These systems of pump control cannot be used for petroleum products because their resistance is too high. Liquids such as water, milk, salt and acid solutions are satisfactory. Even distilled water has sufficient conductivity to operate the relays.

Sequence Control for Two or More Pumps



3 A pressure switch PS starts the first pump on loss of pressure, after which control starts and stops the pumps through electronic circuits to meet the flow demand

Pump-Sequence Control. To automatically start and stop two or more pumps according to demand, the Fischer & Porter sequence control system, Fig. 3, has been designed to solve the problems for petroleum-fuel loading terminals and similar installations. In this control a pressure switch PS starts the first pump on loss of pressure, after which the control can start and stop the pumps according to demand.

A small part of the main-line flow is bypassed and metered by an area-type orifice meter OM. There is a small orifice at the inlet of the area-meter unit as well as the main-line orifice. Flow divides between the two in proportion to their areas. Bypass flow is metered in wide-range uniform-flow-scale area meter, calibrated in main-line flow.

The one moving part of the meter, the float, is brass, stainless steel or other material resistant to the fluid being metered. The extension rod is nonmagnetic, usually stainless steel, but often Hastelloy or even tantalum. The armature is bare magnetic stainless steel (430) or iron enclosed in a corrosion-resistant shell.

(Continued on page 164)

HOTTER, SOONER steam traps.. knock cold spots out of platens

Cold spots in press platens at this large western plywood plant are a thing of the past since they've installed the steam traps that get equipment *hotter, sooner*—Yarways.

Yarway Impulse Steam Traps never allow condensate to accumulate and pull down working temperatures. They discharge the condensate *as fast as it forms.* Result—equipment always operates at highest efficiency.

Couple this fact with other features like small size, easy installation, only one moving part, non-freezing, good for all pressures, low cost—and you know why more than 650,000 Yarway traps have already been installed.

Try a Yarway *for free* in your own plant. Your nearest distributor will supply it. For name, or free bulletin write to . . .

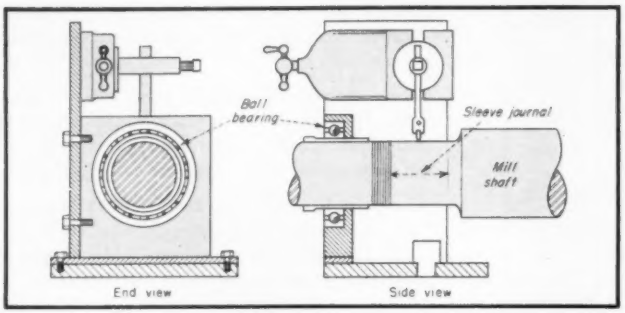
YARNALL-WARING COMPANY
100 Mermaid Ave., Philadelphia 18, Pa.

YARWAY IMPULSE STEAM TRAP

POWER ENGINEERS' NOTEBOOK

PLANT-TESTED IDEAS TO SOLVE PROBLEMS OF DESIGN, OPERATION AND MAINTENANCE

BEARING STAND SPEEDS SHAFT REPAIR ON COAL PULVERIZER



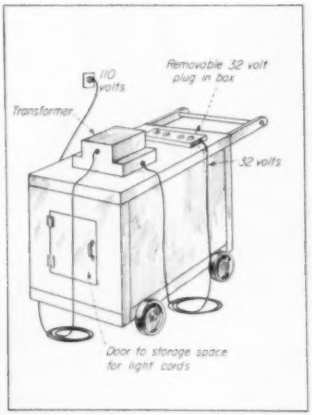
THE BEARINGS on our pulverizers gave us trouble. They mount on the shaft with tapered sleeves. These sleeves kept working loose, causing noise and vibration. We found the shafts to be 0.020 in. undersize at the sleeve journal. We couldn't keep the bearings set right because the sleeves would finally pull all the way up after two or three adjustments. The sleeve journals on all four of our attrition mills had to be built up to original size.

To strip these mills so we could put the shafts in a lathe meant a terrific amount of work. To reassemble would be even harder. We held a few "brain sessions" to figure an easier way to do the job. Finally we decided to remove the bearing pillow block from one end of the mill. We then fabricated a stand to fit this space, shown in the sketch. A large ball bearing pressed into the center of the stand supported the shaft. Enough space was allowed to spray and machine the shaft. The vertical plate, see sketch, supported the compound rest and tool holder.

An air motor driving a rubber-tired wheel rubbed against the outer rim of the rotor disk to turn the shaft while we sprayed and machined. This stand fits either end of the mill shaft. It has saved much time in clearing up our bearing trouble.

F H WILCOXON *Springfield, Ill*

FITTED HANDCART FURNISHES LOW VOLTAGE FOR LIGHTING



THE HANDCART SHOWN in the sketch carries a transformer for converting 110-v ac to 32-v. This low voltage supplies energy for lighting in hazardous locations. Using 110-v lighting, when washing and turbining boilers, washing water tanks, and doing similar chores, introduces unnecessary danger.

The cart can be easily moved about. It carries a 1.5-kw 110/32-v transformer and a 4-position plug-in box. This box is held in position by two angles that can be swung out of the way. A long extension cord between transformer and box allows moving the latter from the cart to more convenient locations, when necessary.

Our cart frame is made of 1½-in. angles with a thickness of ⅛ in. These angles are spot-welded together. Heavy-gage sheet metal spot-welded to the frames closes in the cart. The sides could equally well be made from wood, masonite or other material. The 1.5-kw transformer is securely bolted to the top and has a long extension cord to plug into a 110-v source. The body of the cart makes a convenient storage space for lights and extension cords.

ALLAN ROCKLIN *Chicago, Ill.*

EDITOR'S NOTE: This basic idea is sound, but it should be noted that the National Safety Council recommends using 6-v lighting in the hazardous locations cited above.

REWARD FOR HELPFUL SUGGESTIONS

An idea you or your associates have developed to solve a problem in plant design, operation or maintenance may help somebody else in the same pickle. Why not get the facts down on paper and either take a photo of equipment involved or draw a simple sketch in pencil and send them in for consideration? We'll dress up the material for publication. You'll be paid $20 for each item accepted and have the satisfaction of helping others.

Turn Page for More Plant-Tested Ideas

SUNVIS H.D. 700 OILS PREVENT AND CURE "THROMBOSIS" IN PRODUCTION MACHINERY

Reduced output and extra maintenance cost are the penalties when clogging occurs in the oil circulating system of machinery. But this costly production ill can be avoided. Sunvis H.D. 700 Oils *keep circulating systems clean.* What's more, if trouble exists now, Sunvis H.D. 700 Oils will *free oil lines and bearings of foreign matter.* They go to work immediately loosening up and carrying away any accumulation of dirt, carbon, water, or other contaminants.

Sunvis H.D. 700 Oils are specially developed for modern circulating systems on machines operating where contamination is a troublesome factor. Sunvis H.D. 700 Oils are extremely stable and have long life even under the most adverse conditions. They have inherent rustproofing characteristics, and the high film strength needed to eliminate scoring on heavily loaded antifriction type bearings.

Sunvis H.D. 700 Oils are also fully detergent, dispersive, and resistant to foaming, and are available in all required viscosities.

For further information about Sunvis H.D. 700 Oils, write for booklet P-3.

SUN OIL COMPANY • *Philadelphia 3, Pa.*

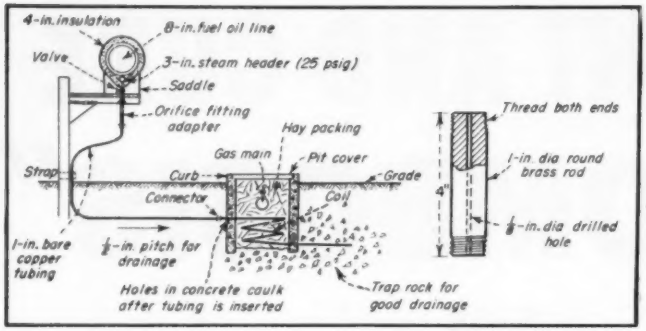
In Canada: Sun Oil Company, Ltd., Toronto and Montreal

SUN PETROLEUM PRODUCTS

"JOB PROVED" IN EVERY INDUSTRY

SUNOCO

CONDENSATE DRIP PREVENTS FREEZING OF GAS REGULATOR

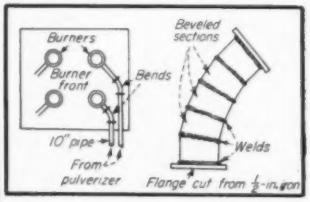


A GAS-PRESSURE REGULATOR in an outside pit had a valve stem that froze up during cold weather. To prevent service interruption we either had to heat the pit or relocate the regulator indoors. Relocation would cause service interruption and entail appreciable pipeline rerun costs. Looking over the site carefully we found that a steam-traced bunker-C fuel-oil line ran past the pit some 10 ft away. At about the same location the steam line was dripped through a bucket trap, which drained into a dry well. Here was heat that could be used to prevent freezeups.

We closed the valve ahead of the trap. The trap was replaced with a pipe-nipple orifice shown in the sketch. We ran 1-in. copper tubing from the outlet of the orifice to the pit underground. About 10 ft of the tubing was wound into a coil inside the pit, see sketch. Open end of the tubing was run through the pit wall to discharge the condensate into the trap rock packing around the pit. This arrangement has proved effective, and we have had no freezeups since it went into operation. Amount of steam drawn from the tracing line for this duty is negligible and doesn't alter its effectiveness in keeping the fuel line warm.

J D CONSTANCE
Cliffside Park, N. J.

FLANGED BENDS REDUCE MAINTENANCE COST OF BURNER PIPE

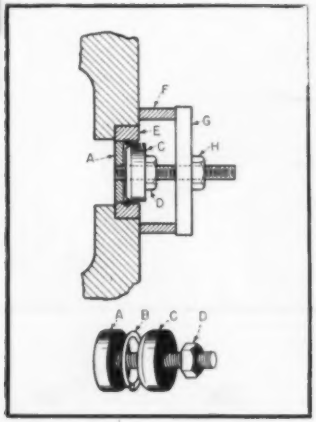


OVER THE YEARS we have spent a lot of money replacing burner pipe on our pulverized-coal furnaces. These prefabricated pipes wore through quite rapidly at the bends. After welding on a patch or two the whole pipe had to be discarded even though the straight sections were still almost new.

To reduce this expense we fabricated our own bends, see sketch. We welded together straight sections and flanges at each end of the built-up bend. The flanges connect to the straight sections which have a long life. We have found that building suitable baffles inside the bend increases its useful service life. This practice has also reduced overall costs. A joint compound seals the flanges against leakage.

J A SWANSON *Princeton, B. C.*

BEARING RACE PULLER GRABS TOEHOLD ON NARROW LEDGE



WE RECENTLY REPAIRED an electric motor on which a ball bearing had to be replaced. It had worn so badly that the ball retainer let the balls fall out of the race. Ordinarily it's easy to pull out the outer race when this happens. But here the cored hole in the motor housing was almost the same diameter as the bore of the ball race, see cross-sectional sketch. We found it was impossible to secure a good hold behind the race with a standard type of bearing puller. What to do? With a little study we came up with the special puller shown in the sketch. It has worked so well that we use it for all similar problems, saving us a considerable amount of time.

Upper sketch shows a partial sectional view of the puller, ready to remove the race *E* by tightening up on the nut *H*. Lower view shows the elements necessary for securing a good grip on the race before pulling. *A* consists of a circular disk with a stud threaded tightly into it. *B* is a split ring made of round wire. Part *C* is a disk, drilled for free fit on the stud. The edge of the disk facing *A* is chamfered so that it can push the wire ring *B* radially outward.

To use, insert *A* into the bearing race. Draw nut *D* down tight. This forces disk *C* against *B*, which expands into the groove of the ball race *E*. This locks the puller to the ball race. Now apply a piece of pipe *F*, a washer *G* and another nut *H* as shown in the sketch. Draw up tight on *H* and the ball race comes out easily without damaging housing or race.

L KASPER *Philadelphia, Pa.*

TIRED OF SPIRALING COSTS ?

Improper water conditioning resulting in carryover, scale, corrosion, excessive blowdown or a host of other troubles, is one sure way to pile up high operating costs in any plant. That's why it's so important—and so profitable—to do something about it *now!*

If you are cost-conscious about the results you expect from water conditioning, BETZ can be of assistance to you. Here in one organization you will find the facilities and services necessary for the efficient solution of *all* industrial water problems. Wherever your plant may be located, our nationwide staff of engineers is ready to serve you. May we have a BETZ Engineer call? He'll show you how you can get results in your plant . . . quickly . . . economically. And, there is no obligation, of course.

W. H. & L. D. BETZ, Gillingham & Worth Streets, Philadelphia 24, Pa. In Canada: BETZ Laboratories Limited, Montreal 1.

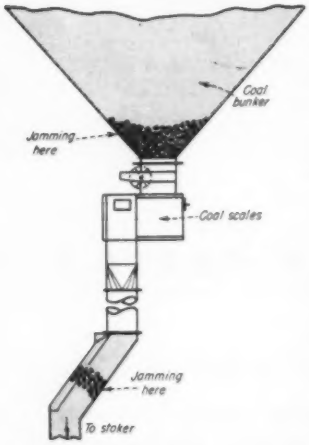
BETZ

BOILER WATER CONDITIONING • COOLING WATER CONDITIONING • INDUSTRIAL WASTE TREATMENT

PROBLEMS FROM THE PLANT

This Month's Question:

CAN WE STOP BUNKER, DOWNSPOUT COAL JAM?



OUR COAL, graded 1½ in. and under, is stored in three large overhead bunkers with downspouts to individual stokers; often coal is mostly fines. When shipped in wet or freezing weather it tends to arch in bunker and downspout as shown in sketch. Fireman must then restart coal flow by hand. This condition has caused us many anxious moments.

We've been wondering if we could purchase or build some device that would relieve these jams when they occur. Sometimes when we rap on bunker underside or downspout with firing tools we can clear the jam. But it doesn't always work. We have both compressed air and electricity handy for driving a device to clear jams. I've noticed that when bunker jam is clear there's seldom any trouble in downspout. So a vibrator of some sort in bunker might do the trick.

We'd like to hear from POWER readers who have faced a similar problem and solved it. What we need are sketches and construction details showing best way of installing equipment to lick this problem. We'd also like details of vibrators for the job.—*LS*

Exercise your engineering wits by submitting answers to this question, fresh from the plant. Suitable material will be paid for; answers with sketches or photos command extra pay

Readers Answer the December Question

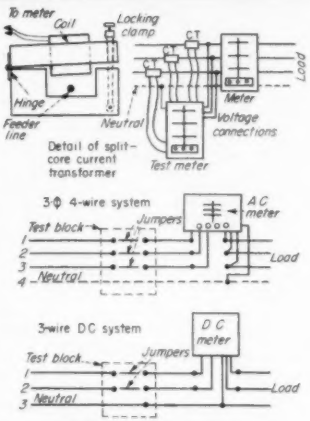
How Can We Check Ac And Dc Whr Meters?

(This question from the December issue is followed by best answers from readers.)

We have both ac and dc motors in our industrial plant. These motors drive fans, pumps, beaters, etc. Several years ago we installed watthour meters for each department so we could properly bill them for current used. We generate our own current, both ac and dc, in our combined steam and diesel power plant.

Recently we've received complaints from several departments saying their bills are too high. They say meters are no longer accurate and demand they be tested. Sketch (p 130, Dec POWER) shows typical hookups for 120-208 v ac, 120-240 v dc.

So here's our problem. Is there any fast means for checking accuracy of ac and dc watthour meters? Can checking be done without taking meter off panel? What instruments are needed and how should they be hooked into circuit? We'd like to make all tests without interrupting service—JB



Practical Test Methods

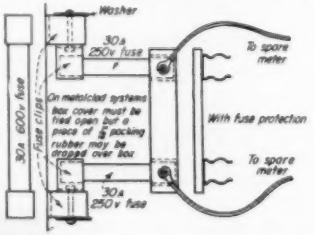
ASSUMING *JB*'s problem is only one of metering kwhr, here's a simple economical test method. With only ac in plant, portable split-core transformer is good.

To test departmental meter, shut down momentarily, remove terminal jumpers and connect meter of known accuracy. With both meters operating, check accuracy of departmental meter against test meter.

Besides dual metering connections, *JB* needs spare ac and dc meters; duplicates of the type now in use by his departments. If two meters of this type are on hand they can be calibrated by a laboratory to assure accuracy. Color-code test-connection blocks and test-meter cases. Use light blue for ac, yellow for dc to prevent confusion and damage.

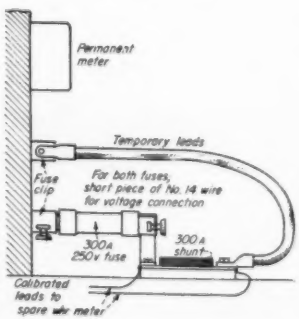
A M PALMER *Brooklyn, N.Y.*

Send Meter to Shop for Tests, Repairs


Washer
30A 250V fuse
To spare meter
On meter/act systems this cover must be fired open but a piece of ⅝ packing rubber may be dropped over box
With fuse protection
To spare meter
30A 250V fuse
30A 600V fuse
Fuse clips

WE'RE UP AGAINST the same problem as *JB*. By using circuits shown in sketches we connect a test meter before sending original meter for repair.

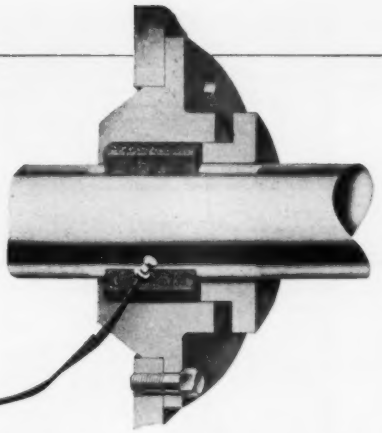
H H BRYAN *Montreal, Canada*


Permanent meter
Temporary leads
Fuse clip
For both fuses, short piece of No. 14 wire for voltage connection
300A 250V fuse
300A shunt
Calibrated leads to spare whr meter

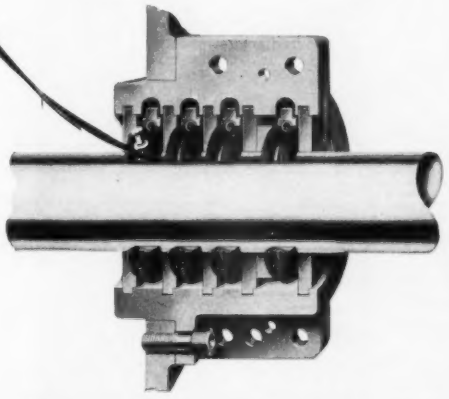
For more plant problems turn page

COPPUS TURBINES

offer you a choice of packing rings



STANDARD METALLIC RING PACKING — Made of high grade asbestos cores encased in specially treated lubricated aluminum foil. Recommended as a low-friction, long-service packing for steam temperatures up to 850 F and back pressures up to 50 lb. Adjustable packing glands keep leakage at minimum. Easy access to packing rings.



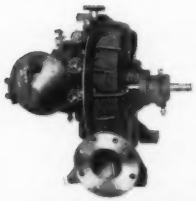
OPTIONAL CARBON RING PACKING — Consists of three carbon packing rings on the pressure side and one beyond the leak-off section. Each ring has three segments held together by a stainless steel garter spring. For back pressures up to 75 lb. Standard for vacuum or gas operation, or when leak-off is desired.

Heavy chrome plating on shaft at stuffing box is common to both types of Coppus packing.

Coppus Turbines ranging from 150 hp down to fractional in 6 frame sizes

FIT TURBINE COSTS TO HORSEPOWER NEEDS

When you buy turbines rated close to your exact horsepower needs, you save plenty of money. That's because turbines are generally priced in proportion to their size. The wide range of sizes of Coppus Turbines promises purchasing economy for you from the 150 hp size down to the smallest. As for operating and maintenance economies, you get them, too, from such other features as: greater number of manually operated valves for individual control of steam nozzles; replaceable cartridge-type bearing housings and others. For complete details . . .



WRITE FOR BULLETIN 135
COPPUS ENGINEERING CORPORATION
163 Park Avenue
Worcester 2, Mass.
Sales offices in
THOMAS' REGISTER

COPPUS "BLUE RIBBON" TURBINES

A: Meter Record

Meter and Load

Department
Department meter No.
Name and make of meter
Type
Capacity in amperes
Location in plant
One division of first dial equals
Connected load
Full-load current in amps.
Max. motor starting amps.
Ground on

Manufacturer's No.
A C
D C
Volts
Meters
Lighting
Line power factor

Constants

Test constant K_t
Watt-second constant K_s
Register constant K_R
Current trans. ratio

Watthour-meter const. K_{wh}
Register constant K_R
Gear ratio R_g
Pot.-trans. ratio

Meter Test Data

Meter "As Found"				Meter "As Left" (after adjust)			
Date	Percent	Date	Percent	Date	Percent	Date	Percent	Remarks

Record of Test Data

Indicating instruments	FULL LOAD				LIGHT LOAD			
	Date	Date	Date	Date	Date	Date	Date	Date
Percent of load								
Standard volts								
" amps								
" watts								
Meter watts								
Revolutions								
Stop watch seconds								
% Fast								
% Slow								
Aver. error in %								
Rotating Instrument								
Revolutions of rot std meter (correct No.)								
" meter (actual)								
% accuracy								
Observed rev. Std. dial / Meter dial								
True Ratio rev. Std. dial / Meter dial								
% accuracy equals								
Standard rev. times test constant=stand. ard watts								
Meter rev. times test constant=meter watts								
% accuracy								

Instruments

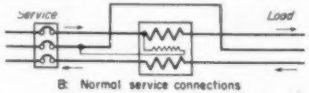
Ammeter No.
Stop Watch
Voltmeter No.
Rotating Std. No.

Conditions

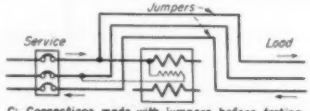
Register reading
Creep due to
Rev. Min. Sec.
Watthours per day
Rate of Creep
Hours per day
Errors in starting

Remarks

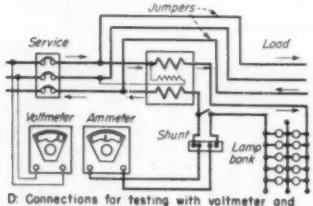
(Under this space, note condition of jewel, pivot, top-bearing gear, worm gear, field coil, shunt coil, resistance, armature, commutator, brushes, dial hands, disc, etc.)



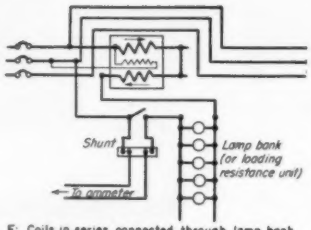
B: Normal service connections



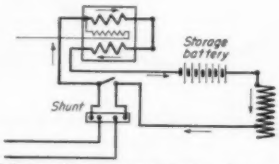
C: Connections made with jumpers before testing, either for each loaded coil or to prepare for testing coils in series



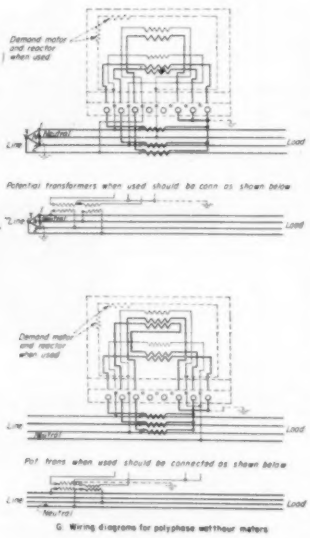
D: Connections for testing with voltmeter and ammeter and lamp bank, load box or water rheostat



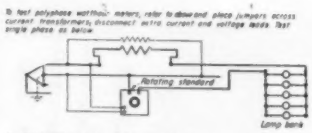
E: Coils in series connected through lamp bank for small currents



F: Coils in series connected through a storage battery for larger currents



G: Wiring diagrams for polyphase watthour meters



H: Three-phase 4-wire delta connections. For 3Φ 4 wire Y, similar connections may be made for single-phase testing

Do It on the Job

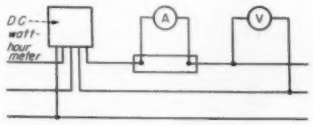
MANY THOUSANDS of meters have been tested on the job by public-utility metermen. With only a few ac and dc meters in plant, best procedure is to jump meters, pack them carefully and send to manufacturer. He'll test, calibrate and adjust them at moderate cost. Charge each department for energy during the period meters are out by figuring average consumption per hour. Multiply this by hours worked during period.

Assign two men to meter testing if it's to be done in plant. Send them to a local utility where they can observe and learn proper test methods. Number each meter and label it ac or dc. Number will correspond to department served by meter and will be different from manufacturer's number. Prepare complete record for meter as in Sketch *A*. Secure bulletins from manufacturer of meter so wiring diagrams, constants and dial gear ratios are on hand.

Sketches show dc meters for small and large capacities. Use jumpers, shunts, ammeter, voltmeter, lamp bank of 110 or 220 v, or a form of variable resistance, storage battery and tools for adjusting meter. Copy of *Electrical Metermen's Handbook*, Edison Electric Institute, is also helpful on testing jobs. An accurate stop watch will be needed for testing, too.

Since *JB* didn't indicate ac meter sizes, I assume that department has connected load in excess of normal meter and is metered by use of current transformers. Place jumpers across secondaries of current transformers so meter can be disconnected from them and ready for artificial loading through lamp bank or variable resistance. Circuits in Sketch *H* are for loading and testing as a single-phase meter. If not convenient to use smaller voltage from one phase to neutral, then a double lamp bank can be used across phase in question. Rotating standard watthour meter is in common use. Refer to a standard text for details on meter test calculations.

ELMER L KYLE *Detroit, Mich.*



Three Quick Tests

USE these quick not-too-accurate tests:

1. Connect known load, such as 10-100-watt lamps across each whr meter for an hour. Compare 1000 whr to meter reading during same period. This could be done when there's no power demand.

2. Build test sets, sketch. Take readings every 5 min for 1 hr. Average result of volts × amps should approximate whr-meter reading.

3. For polyphase ac, measure current and line voltage for unity pf. Ac watts $= \sqrt{3} \times$ volts × amps. Take readings every 5 min and compare. Fairly accur-

(Continued on page 176)

The case of the voracious

cooling water

Inlet-end corrosion of a rather vicious character was causing serious trouble in the condenser tubes of a large power company's seaboard plant.

With the utility's engineers, Anaconda set up a three and one-half year test of the corrosive action of the cooling water used at this plant on a variety of tube materials, including Admiralty alloys, aluminum brass and aluminum bronze, and copper-nickel alloys.

At the end of this period, careful observation and analysis of results proved Ambraloy 927 (Anaconda aluminum brass) to be most advantageous in over-all performance and cost for this application.

This story describes a typical service by Anaconda's Technical Department. Through this department, Anaconda has saved money and trouble for many utilities and industrial companies faced with condenser and heat exchanger problems. May we help you? The American Brass Company, Waterbury 20, Connecticut. In Canada: Anaconda American Brass, Ltd., New Toronto, Ontario.

for efficient heat transfer

ANACONDA

HEAT EXCHANGER TUBES

80594

TECHNICAL BRIEFS

ENGINEERING DEVELOPMENTS HERE AND ABROAD DIGESTED FOR BUSY POWER MEN

REVIEWED IN THIS ISSUE

WATER TREATMENT: Prevention of Embrittlement Cracking • Simplified Process for Determining Steam Purity

HYDRAULICS: Index Testing of Hydraulic Turbines • Investigation of Flow Through Screens

HEAT EXCHANGERS: Expanded Tube Joints in Heat Exchangers • Aluminum Alloys in Heat Exchangers

FUELS AND FIRING: Radiant-Gas Burners • Combination Spreader Stoker and Waste-Fuel Furnaces • Residual Oil as Gas-Turbine Fuel • Review of Control of Air Pollution

STEAM JETS: Temperature Effects of Entrained Fluid on Steam-Jet Ejectors • Effects of Molecular Weight on Steam Jets • Flow-Rate Measurement in Steam-Jet Tests

Directions for ordering papers are given on page 138

Water Treatment

THE PREVENTION OF EMBRITTLEMENT CRACKING, *by A A Berk, U. S. Bureau of Mines.* Between 1935 and 1940, three practical treatments were found to prevent embrittlement cracking in detector units under laboratory conditions. The earlier work, published in 1930 by F G Straub, indicated two of these treatments should be effective. The effectiveness of organic substances, such as tannin and lignin, of sodium nitrate, and of eliminating free sodium hydroxide from the boiler water by maintaining only the alkalinity corresponding to trisodium phosphate, has been proved during the past decade.

In summarizing the embrittlement detector test data, results in table below show effectiveness of nitrate, tannin, and zero caustic treatments. Nitrate and quebracho tannin are inhibitors of intercrystalline corrosion in hot concentrated caustic solutions. The zero caustic treatment, also called the "coordinated phosphate" method or the "captive alkalinity" method, prevents formation of concentrated solutions of caustic.

The tests in which sodium nitrate was the principal chemical show clearly its effectiveness as an inhibitor. In four tests specimens were reported as cracking when a 0.3 minimum ratio was maintained. In every instance, though, it appeared that the nitrate concentration had been very low for a significant period of the test. The tannin extract had not been as effective as nitrate. As you could expect, when boiler water contained no free caustic, cracking did not result. *ASME paper No. 50-A-84.*

SIMPLIFIED PROCESS FOR DETERMINING STEAM PURITY, *by S T Powell, consulting engineer, and I G McChesney, Rochester Gas & Electric Corp.* Accurately measuring dissolvable solids in steam by conductivity methods has been solved with varying degree of success by different testing procedures. The objective has been to measure only dissolved solids contained in the condensed steam.

Basic principle of the conductivity method depends on collecting a representative sample of steam and processing that sample in such a way that the conductivity of the steam condensate can be measured without interference from dissolved gases or impurities picked up in sampling and testing apparatus. Most troublesome of all problems is preventing gas contamination or degasifying a contaminated sample. The best solution would be to prevent initial contamination of condensate as it is formed.

If the steam sample is drawn off at high velocity so the exposed surface of the condensate particles are thoroughly scrubbed by steam passing through a sampling tube, and if this passage is at high velocity, it assures the exposed surface of all condensate particles staying at or very close to the boiling point for the pressure established at any particular place in the sample line.

Sample enters a standard sampling nozzle in the steam main, passes through a high-pressure stainless-steel gate valve and into a sampling line of stainless-steel capillary tubing arranged in the form of a coil. This apparatus is designed for use when sampling steam in a pressure range from somewhat above atmospheric to extremely high pressures; it discharges at atmospheric pressure. *ASME paper No. 50-A-85.*

SUMMARY OF BOILER TESTS WITH THE EMBRITTLEMENT DETECTOR

Principal chemical	No cracked specimens			Specimens cracked—ratio high [a]		
	30 days	60 days	90 days	30 days	60 days	90 days
Sodium nitrate [b]	190	140	404	1	1	2 [e]
Quebracho	78	46	49	4	4	6
Zero caustic	7	21	38	—	—	—
None above [d]	194	100	104	305	152	129 [e]

[a] A high ratio of sodium nitrate or quebracho tannin to alkalinity (carbonate plus hydroxide) as NaOH of 0.3.

[b] Boiler water had high natural nitrate concentration.

[c] Nitrate concentrations had not been maintained at indicated level.

[d] Includes 50 specimens not cracked when boiler water had high concentration of (1) tannin-type organic matter from natural sources (2) silica equivalent to or greater than "free sodium hydroxide" (3) sodium chromate.

[e] 586 cracked in a total of 984 (60%).

Hydraulics

INDEX TESTING OF HYDRAULIC TURBINES, *by Grant H Voaden, S Morgan Smith Co.* An index test of a hydroelectric unit is a means of determining efficiency over its full range of gate opening or output. This efficiency is relative to an assumed or estimated peak efficiency. The relative efficiency may be that of the turbine alone or of the complete unit, whichever is desired.

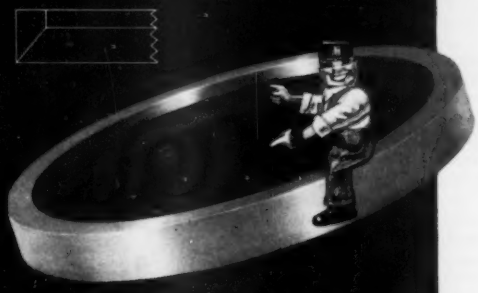
The principal benefits derived from an index test are the gate opening and load at which peak efficiency is obtained and also the relative efficiencies at other gate openings and loads. Thus

(*Continued on page* 138)

Need special high pressure gaskets such as these?

Flare-type Gasket with Bellows Action

Delta Joint Gasket



Pressure Seal Joint Gasket

We tailor them to your specifications

If you require high pressure gaskets made to extremely close tolerances—for service exceeding 10,000 psi, for example—and fabricated to any desired diameter or cross-section, why not look into the special service that Goetze offers for making these gaskets to your order.

The gaskets shown above are typical of the wide variety for high pressure service that have been made to order for Goetze customers. The flare type gasket with bellows action illustrated at upper right is but one example of what Goetze "know-how" can accomplish.

Goetze has had over sixty years of experience in making specialized metallic gaskets for industry's most complex jobs. Modern machines—many of them specially designed and built by Goetze—enable Goetze craftsmen to produce gaskets of any required design, shape or size...and deliver them with remarkable promptness.

For further information about Johns-Manville Goetze gaskets, write for a copy of the new Goetze Gasket Catalog. Or send us a drawing or template for assistance on your specific problem. Address Johns-Manville, Box 290, New York 16, N. Y.

JM

Johns-Manville Goetze GASKETS

THERE'S A JOHNS-MANVILLE PACKING AND GASKET FOR EVERY SERVICE.

the most economical use of water and distribution of load among the units on the system are permitted.

The object of this paper is to (1) bring to the attention of operating companies the benefits derived from index tests of hydraulic turbines, especially the adjustable-blade propeller or kaplan type (2) enumerate and discuss methods of measuring relative discharge, and hence relative efficiency (3) present an example of an index test of an adjustable-blade propeller turbine in sufficient detail to provide a guide to conduct such a test.

The author reaches the conclusion that much useful information can be economically obtained from an index test of a reaction turbine. Such a test may be conducted in all respects except for the measurement of discharge, in accordance with the *ASME Power Test Code*. There is no definite assurance that the best possible efficiency is being obtained from an adjustable-blade propeller turbine unless a field check of the blade-gate relation is made. An index test is a relatively inexpensive means of determining the optimum blade-gate relationship. It is recommended that all reaction turbines, especially adjustable-blade propeller type, be tested by the index method where absolute methods are considered inadvisable because of expense or some unusual condition. *ASME paper, No. 50-A-52.*

AN INVESTIGATION OF FLOW THROUGH SCREENS, *by W D Baines and E G Peterson, Iowa Institute of Hydraulic Research, State University of Iowa.* This report covers investigations of the effects of relatively coarse wire and perforated plate screens placed perpendicular to fluid flow. The effects investigated were dictated by a study of the use of screens and were divided into three main categories: (1) pressure drop across the screen (2) modification of the velocity distribution caused by the screen (3) turbulence resulting downstream from the screen.

The authors conclude there is a particular combination of screen characteristics that is most efficient for a particular type of screen application. For example, a single screen of large bars is more effective in creating turbulence, whereas several screens of small bars are preferable in dissipating turbulence.

To eliminate variation in velocity distribution, a series of uniform screens of low to moderate solidity ratio is indicated. On the other hand, for the production of velocity variation, a single screen of corresponding solidity ratio may be used.

If a considerable dissipation of energy, that is, reduction of pressure, is required, this may be obtained with a single screen of high-solidity ratio, but at the expense of even-velocity distribution. Preferred is a series of screens of moderate-solidity ratio.

Shape of the screen element is always of secondary importance, because it influences the energy loss but not the general distribution of velocity and turbulence. In no case is a solidity ratio greater than 0.5 recommended, owing to the instability that occurs at higher values. By means of the relationship presented in this report, quantitative predictions may be made of flow modification to be expected in any such screen application, provided the screen Reynolds' number is above 100. *ASME paper, No. 50-A-23.*

TO OBTAIN COMPLETE TEXT

Material for these abstracts comes from the following source:

American Society of Mechanical Engineers, annual meeting, Statler Hotel, New York, N. Y. Nov 26-Dec 1, 1950. Identified by initials ASME and obtainable through ASME, 29 W 39th St, New York 18, N. Y.

Heat Exchangers

EXPANDED TUBE JOINTS IN FEEDWATER HEATERS AND HEAT EXCHANGERS, *by S S Fisher and G J Brown, Detroit Edison Co.* Since feedwater heaters and other heat exchangers are classed as unfired pressure vessels, their component parts are designed and manufactured according to specific national and state code requirements. These requirements cover all manufacturing procedures, except the rolling in of tube joints that fasten tubes to tube sheets or headers. It stands to reason that these roll joints have a very important bearing on continuous and satisfactory operation of all heat exchangers. Since they are not covered by code, little guidance and information are available.

Tube expanding, also known as tube rolling or rolling-in of tubes, has been practiced for many years. Properly performed, it produces pressure-tight joints between tube and tube sheet that are dependable and capable of withstanding heavy loads and high pressure.

Experience shows that each tube and tube sheet combination of different metals and tube sizes requires a definite degree of expanding to develop its optimum joint strength. Under-rolling, for example, produces joints that leak or fail. Over-rolling injures the metal of the tube and, if rolling is continued, the adjacent tube sheet metal.

Parallel expanders are the preferred method of rolling tubes. Parallel expanders consist of a loose central mandrel that drives by contact three or more rollers mounted in slots machined into the expander body. Both mandrel and rollers are tapered, but the taper of the rollers is about half that of the mandrel and opposite to it. The slots permit the rollers to rotate freely and move toward or away from the expander axis, a distance corresponding to the actual movement of the driving mandrel. By placing roller slots at an angle of about 2 degrees to the expander axis, the expanders become self-feeding.

The authors continue to review practices of rolling-in heat-exchanger tubes. They recommend the optimum degree of expanding pre-determined by tests conducted in advance of actual rolling operations. Simple testing means and three applicable rolling methods are described and discussed. *ASME paper, No. 50-A-124.*

ALUMINUM ALLOYS IN HEAT EXCHANGER CONSTRUCTION, *by E G Kort, Alcoa Process Development Lab, and J F Hamilton, Aluminum Co of America.* With any heat exchanger material, its behavior with water is of primary importance. In this respect, years of service experience show aluminum heat-exchanger tubes give satisfactory life in fresh and salt cooling water. Aluminum has excellent resistance to corrosion by neutral and nearly neutral waters of pH values from 4.5 to 8.5, even if these cooling waters contain salts or alkali or alkaline earth materials. Compounds of heavy metals, like copper, lead, tin, or nickel, may cause pitting corrosion of aluminum.

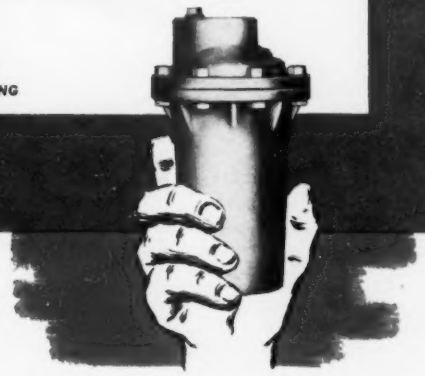
In many applications aluminum tubes may be substituted for tubes of other materials on a similar size or thickness basis. Where pressure and temperature conditions are extreme, it may be necessary to make some changes in thickness of aluminum tubes.

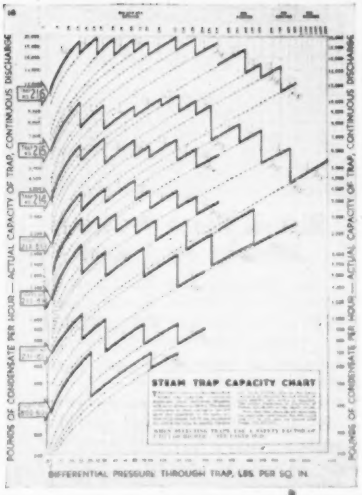
In conclusion, condensers and heat exchangers constructed with aluminum alloys show excellent performance over many years. The problem of designing with these alloys is currently difficult because of the status of various construction codes. In the past few years the need for inclusion of aluminum within the structure of the *ASME Unfired Pressure Vessels Code* has become increasingly apparent. Various ASME committees are working on a non-ferrous code, and it is hoped they will arrive at a workable solution in the near future.

(*Continued on page* 156)

Only actual hot condensate capacities give a true picture of steam trap value

YOU KNOW THE CAPACITY WHEN YOU BUY AN ARMSTRONG




STEAM TRAP CAPACITY CHART
POUNDS OF CONDENSATE PER HOUR—ACTUAL CAPACITY OF TRAP, CONTINUOUS DISCHARGE
DIFFERENTIAL PRESSURE THROUGH TRAP, LBS. PER SQ. IN.

IT PAYS TO KNOW BEFORE YOU BUY!

THE ARMSTRONG STEAM TRAP CAPACITY CHART is based on hundreds of tests with hot condensate. You can depend on its accuracy.

SEE OUR CATALOG IN SWEETS OR CEC

THEORETICAL calculations fail entirely to give a true picture of trap capacity. Orifice tests fail to account for capacity losses caused by pipe friction. Tests with cold or warm water do not take into consideration the capacity-reducing effect of flash steam. Only tests with actual trap hookups handling hot condensate will tell you the true continuous discharge capacity of a steam trap—and those are the capacities Armstrong gives you.

If capacities are misleading you may buy a trap too small for the job. Or, if you compare different makes of traps on a price basis you must know if they are comparable on a capacity basis or the comparison means nothing.

Dollar for dollar and size for size Armstrong steam traps give you greater capacity—another reason why they are your wisest buy. Your nearby Armstrong Representative can supply you. Call him for recommendations.

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The 36-PAGE STEAM TRAP BOOK gives Armstrong trap capacities and tells how to select the right size trap for every job. Ask for a copy.

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POWER NEWS

BUSINESS ITEMS • APPOINTMENTS • FOREIGN FIELDS
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U. S. PETROLEUM SUPPLY AND DEMAND

(Daily averages in thousands of barrels)

SUPPLY	1950	1949	1948	1941
Crude production	5405	5042	5520	3842
Natural gasoline, etc	493	428	402	231
Imports, all oils	844	642	514	266
Total	6742	6112	6436	4339
DEMAND				
Domestic demand	6455	5792	5775	4071
Exports, all oils	288	327	368	298
Total	6743	6119	6143	4369

Petroleum Demand Sets Record

► FOR THE EIGHTH consecutive year domestic demands for petroleum products hit an all-time peak. Total demand, including exports, resumed its upward swing to also set a new high.

Among the domestic records for the 12-month period, ending December 31, 1950, were those for well completions, refinery capacity, runs to stills, production of motor fuel, natural-gas liquids and natural gas. World production of crude oil also established a new all-time high.

Domestic crude-oil production surpassed the 1949 total but it fell short of the 1948 record by a small margin. Liquid petroleum (crude oil and natural-gas liquids) passed the 2-billion barrel mark for the second time in history, topping the domestic total for 1949 but not quite reaching the 1948 peak.

Total demand in 1950 was about 10% over the 1949 level of 2,233,000,000 barrels. The abnormally mild weather in the first and last quarters of 1949 kept the year's figures below anticipated peak.

The global production of crude oil, 3,786,000,000 barrels, 350 million over the previous high in 1948, came very close to an even split between wells inside the U. S. and those outside. The outside wells brought in 1,813,000,000 barrels; the inside, 1,973,000,000. U. S. ranking in crude-oil production declined another two points in 1950 so it now stands at 52% of world production. Outside well production has risen steadily since the war, moving up from 37% in 1946 to 48% today.

The major domestic products of petroleum are motor fuel and fuel oil. Motor fuel went beyond the billion-barrel mark for the first time with an increase of 6% in 1950 over 1949. Demands for gas, oil and distillates went up 19% over 1949. Residual fuel oil suffered a decline for the second year in a row so over-all fuel-oil demand stayed below the 1948 total. There are an estimated 5,100,000 home oil burners now in use, about a 14% jump in one year.

Zirconia Labors at New Jobs

The Norton Co recently announced the commercial availability of stabilized zirconia—a new refractory with startling properties. It has one-third the thermal conductivity of pure magnesia or alumina. It melts at a range of 4620 to 4710 F. In contrast to its good insulating qualities, zirconia is very heavy. Its true specific gravity is 5.6, but in commercial shapes it can be obtained at sp gr varying from 2.5 to 4.4.

Pure zirconia behaves very erratically while expanding and contracting. When heated it expands uniformly by about 0.8% until about 2000 F where it suddenly contracts. At about 2250 F the initial expansion reduces to about 0.4%. When cooled from this level, its expansion drops to about 0.1% at about 1850 F. It then suddenly expands to about 0.8% when cooled to about 1450 F, after which it gradually contracts. It ends up with greater length at room temperature than it initially had. This made pure zirconia crack with temperature changes.

Research triumphed by greatly modifying the expansion behavior so stabilized zirconia became thermal-shock resistant. Stabilized zirconia has about 5% lime as the stabilizing agent. Small amounts of silica and oxides of titanium, iron and hafnium may be included. Zirconia is made from certain beach sands found in Australia and Florida. Electric furnaces reduce the ore.

Because stabilized zirconia costs about four times as much as the best super-refractories, it must find new applications. Two characteristics make it a versatile worker: (1) high degree of chemical neutrality at high temperature (2) high electrical resistance at low temperatures and excellent conductivity at high temperatures. Induction furnaces can be made by building up rings of zirconia, which heat up by high-frequency electrical currents induced in them from an outer winding. Resistance furnaces are also built of zirconia. Specific resistivity of 2300 ohm-cm at 1290 F drops to 0.37 ohm-cm at 3990 F.

About 200 different application projects are in the pilot plant or development stage. They include furnace linings for gas synthesis, metal melting, and ceramic processes, kiln furniture, nitrogen fixation and linings for jet and rocket engines.

As the need for this new refractory material becomes more apparent from the above pilot projects and the demand grows, it is hoped its relatively high cost can be brought down.

Midwest Power Conference Schedules Big Program

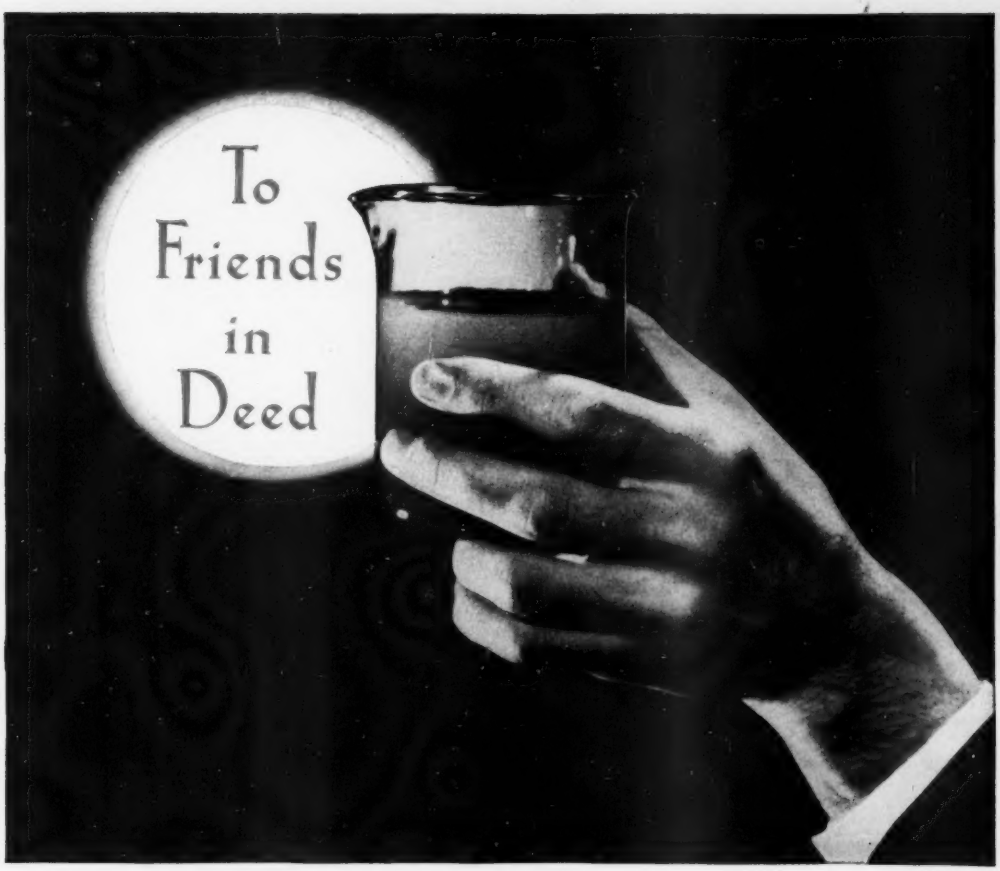
The 13th annual meeting, April 4-6, 1951, of the Midwest Power Conference at the Sherman Hotel, Chicago, Ill. promises an interesting program covering all principal phases of the power industry.

This conference sponsored by ten Midwestern universities and nine Midwestern and national technical societies will have 30 sessions, six on topics of general interest, the remainder to specific technical problems.

The mechanical sessions will include papers on diesels, gas turbines, flyash problems, gas turbine locomotives, steam and power generation. In addition, there will be special descriptions of the Ridgeland Station of Chicago's Commonwealth Edison Co, discussions of soot removal and fireside deposits, as well as considerations of water supply and conservation.

A symposium on organic materials, sessions on ion exchange and cooling-tower problems highlight the water technology program.

For "Coming Events" see page 218



SEVERAL months ago a basic chemical shortage, created by strikes, caused Nalco a great deal of difficulty in supplying adequate quantities of water treatment chemicals to established users.

Uniformly, Nalco System users displayed a wonderful cooperative spirit and understanding patience during this trying period.

We wish to take this public means of thanking and expressing our pride in our friends in deed—and to note with satisfaction that not a single shutdown was reported as being necessary because of an inadequate supply of Nalco chemicals.

With the immediate prospect of greater military and defense uses of many chemicals, it is particularly reassuring to know that Nalco and Nalco System users have a fully demonstrated ability to work closely together in turning adversity into success.

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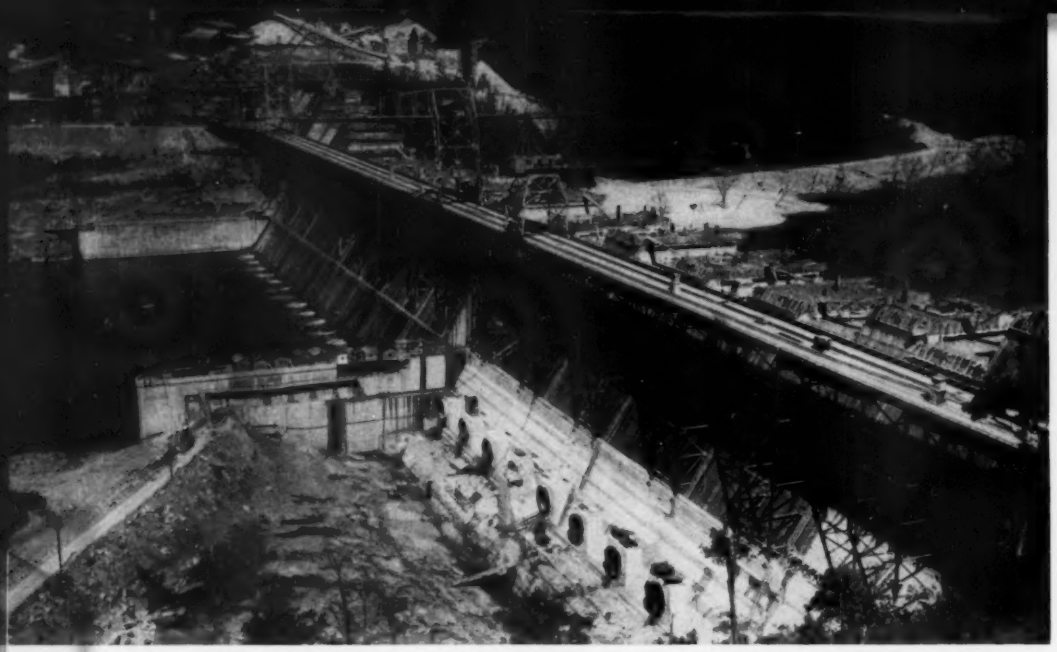
THE *Nalco* **SYSTEM . . . Serving Industry through Practical Applied Science**



BULL SHOALS DAM. This $78 million hydroelectric and flood-control project has concrete gravity dam 2255 ft long, 284 ft high. It will form 5,400,000-acre-ft reservoir. Plant is designed for eight 52,000-hp units, of which three are being installed

7-Mi Conveyor Builds Bull Shoals Dam

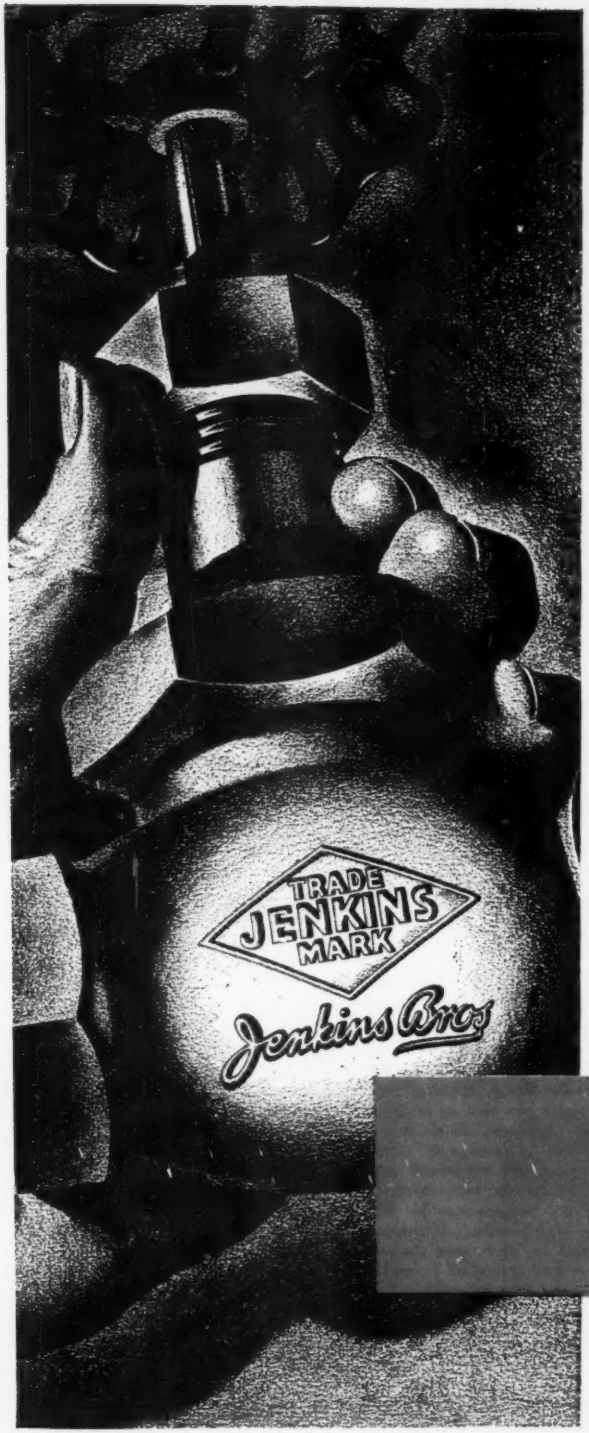
CONVEYOR IDLERS. A total of 14,000 idlers carry this belt on its 7-mile trip from the quarry atop Lee Mountain to deliver the crushed rock for building Bull Shoals Dam

► A BELT CONVEYOR 7 miles long is completing the task of moving a 4 million-ton mountain across two valleys to construct the manmade mountain, Bull Shoals dam and power plant on the White River in Arkansas. This $78 million hydroelectric and flood-control project is scheduled for completion in 1952.

The dam is a concrete-gravity type, 2255 ft long, 284 ft high, and will form a reservoir of 5,400,000 acre-ft capacity. Designed for eight 52,000-hp main units and two 1500-hp service units to operate under 239- to 132-ft head, plant will have a total capacity of 419,000 hp, of which 159,000 hp is being installed.

To perform this modern miracle of construction, one of the longest belt conveyors in the world was built across the rugged rolling terrain of the Ozarks in northern Arkansas. This belt runs at 525 ft per min on 14,000 rollers and carries 650 tons of crushed rock per hour. As one of the construction engineers described it: The mountain is coming to Mohammed on a roller coaster.

In addition to this conveyor, three miles more are used on the project. M H Slocum, project manager, Ozark Dam Constructors and Flippen Materials Co, elected to use belt conveyors, instead of other means. All the rollers and part of the belting were designed and built by Hewitt-Robins, Inc.



"We will sign it with our name"

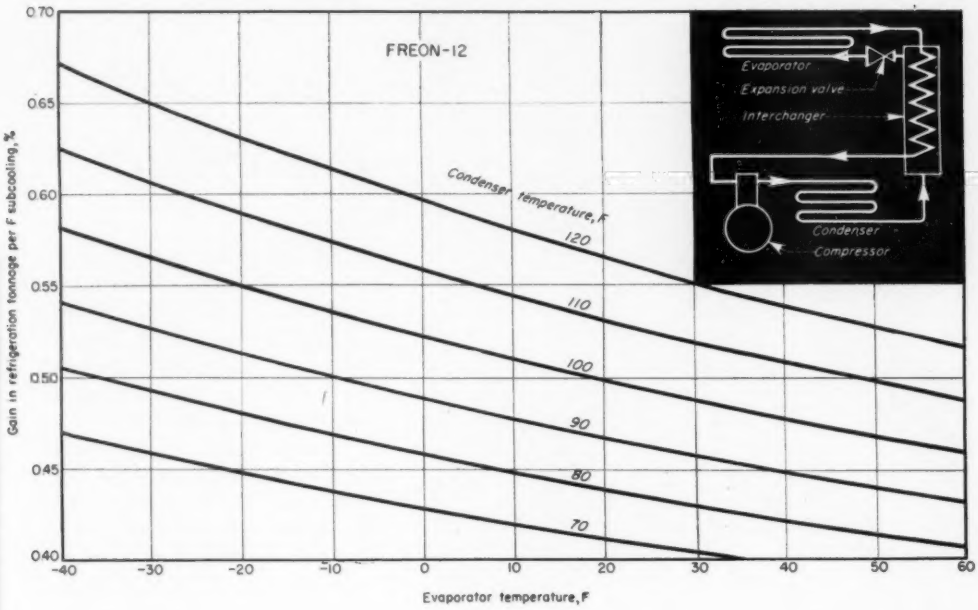
Few things in life are as precious to a man as his name. He bestows it with pride on his heirs. He does not sign it lightly. To the man of integrity, his signature is not so much a means of identification as an evidence of good faith.

When the Jenkins brothers were satisfied they had made the best valve money could buy, they *signed* it with their name. Today, as for over three quarters of a century, that signature — forming, with the famous Diamond, the Jenkins trade mark — is more than a symbol of the maker's pride in his craftsmanship. It is the mark of a friend you can trust.

Jenkins Bros., 100 Park Avenue, New York 17. Jenkins Bros., Ltd., Montreal.

JENKINS
VALVES

Number 225

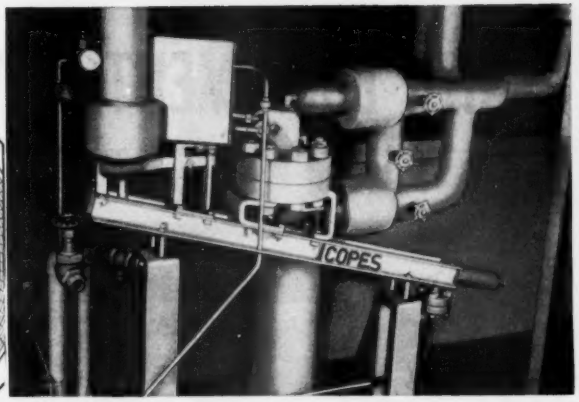


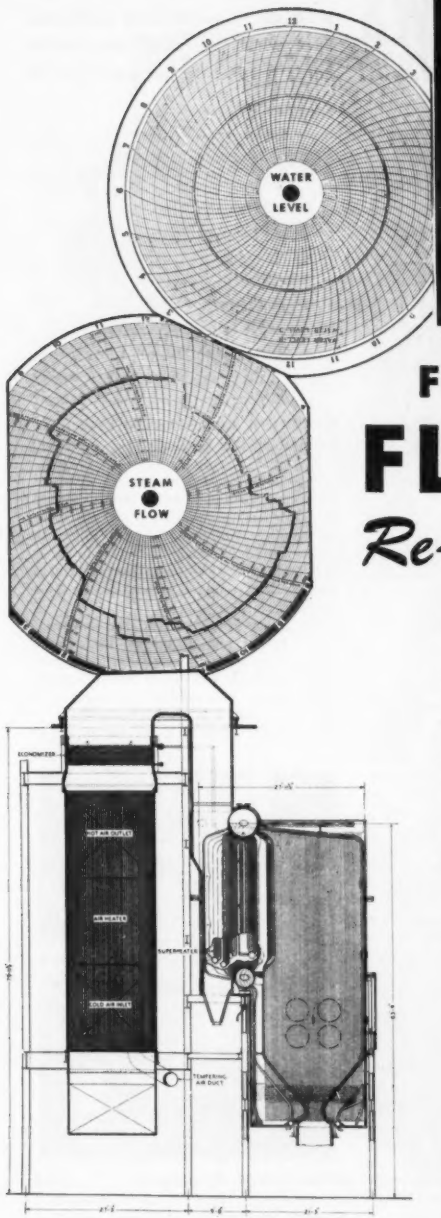
Interchanger Raises Refrigerating Capacity

► AN INTERCHANGER hooks into a compression refrigerating system as shown in the sketch above. This counterflow heat exchanger makes the relatively cold Freon vapor leaving the evaporator subcool the liquid Freon leaving the condenser. The colder the Freon entering the expansion valve, the greater the heat it can pick up in the evaporator. Thus a constant flow of refrigerant can do more cooling.

The graph shows the gain in tonnage or refrigeration for various levels of condenser and evaporator temperatures. For instance, at 20-F evaporator temperature and 100-F condenser temperature the tonnage can be increased by 0.50% for each degree of subcooling. If the interchanger subcools the Freon liquid by 10 F, then the total gain is 0.5x10 = 5.0%. That is each pound of Freon-12 will pick up 5.0% more Btu's in the evaporator.

J D CONSTANCE *Cliffside Park, N. J.*





Unit No. 1. B & W Type FH integral furnace boiler rated at 275,000 pounds per hour. Pulverized coal. 900 psi at superheater outlet.

FULLY AUTOMATIC FLOWMATIC

Re-ordered for 2nd UNIT

AT THIS LARGE UTILITY

Looking for proof of performance? This midwestern utility installed COPES Flowmatic Boiler Feed Control on its first 900-psi, 910-F. boiler. The charts show how water level was held within plus-or-minus one-half inch despite the varying boiler load. As a result, fully-automatic COPES Flowmatic was ordered for the second duplicating steam generator.

Actuated by rate of steam flow and drum water level, the COPES Flowmatic holds level within close limits and matches feed flow to steam flow, regardless of speed or extent of the boiler load changes. For the full story of this important utility installation, write for Performance Report 487.

NORTHERN EQUIPMENT DIVISION
CONTINENTAL FOUNDRY & MACHINE COMPANY
311 GROVE DRIVE, ERIE, PENNSYLVANIA

COPES

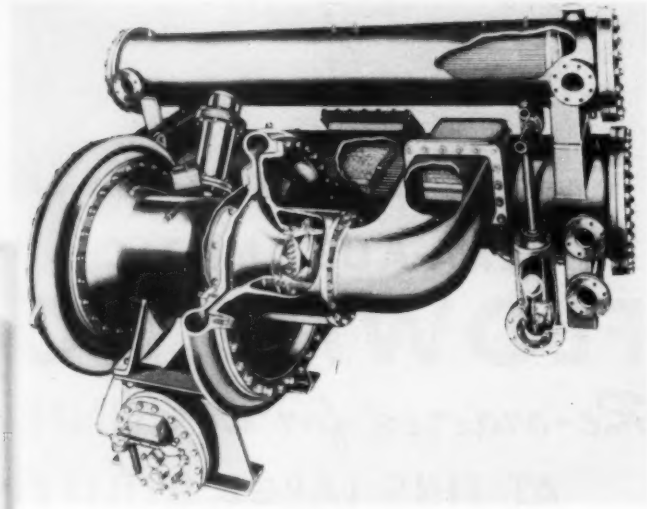
Headquarters for . . .

Boiler Feed Water Control . . . Excess or Constant Pressure Control, Steam or Water . . . Liquid Level Control . . . Balanced Valves . . . Desuperheaters . . . Boiler Steam Temperature Control . . . Hi-Low Water Alarms.

PLANT EQUIPMENT NEWS

Published monthly as a service to readers

Your information center for new products to solve plant problems. Spot what you need, use handy cards p 194a, to get more details



Centrifugal Refrigerating Unit

P311 • Lower operating, maintenance and installation cost for a wide range of comfort and industrial air-conditioning systems seems indicated by the new *CenTraVac* centrifugal water-chilling unit above. It employs the first hermetic centrifugal refrigeration unit designed for systems served by compressors with capacities of 45 or more tons of refrigeration. Refrigerant is F-113, a member of the stable Freon refrigerant family.

Maintenance economies seem to come from the use of the hermetic-seal design of the 2-stage compressor motor assembly. It eliminates shaft seals, a major source of gas and air leakage and compressor failures. Further savings should result from the direct drive, which eliminates gearboxes, sources of noise and friction. Impellers for both stages of compression mount directly on the constant-speed motor.

CenTraVac can be started or stopped by pushbutton control or controlled thermostatically to modulate stop and start automatically, thus maintaining constant temperature in the cooling water supplied to an air-conditioning system. The unit is said to have an almost constant ratio between cooling demand and power consumption through its normal operating range. It will be manufactured initially in five sizes covering a general range of 40 to 52 F, leaving chilled-water temperatures, and 80 to 100 F, leaving condensing-water temperatures. Approximate capacity ranges go from 45 to 55, 65 to 95, 95 to 125, 115 to 155, and 140 to 190 tons.

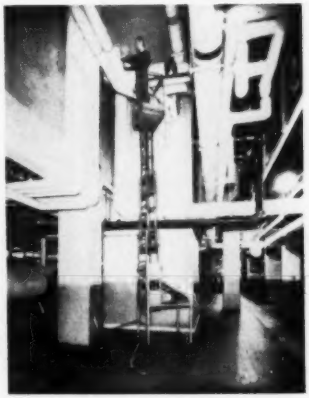
Trane Co, La Crosse, Wis.

OUTDOOR COMBINATION BREAKER-RECEPTACLES P300

Magnetic circuit breakers and receptacles are incorporated in one compact enclosure. Receptacles are already wired in. Only connections necessary are those to the line. Equipment is available with one to four fully magnetic circuit breakers in combination with one or two receptacles. Ratings are supplied in any combination up to 50 amp each.

Equipment is enclosed in corrosion-proof steel housing measuring up to 15 in. high, 6¾ in. wide and 3½ in. deep for the largest size. Breakers will carry rated current continuously since no heat is generated in the box. *Bulletin EB 2013* available.

Heinemann Electric Co, Trenton, N. J.



EXTENSION SCAFFOLD P308

Electrically operated extension scaffold permits working up to heights of 26 ft above floor level. Ball-bearing swivel casters on all four legs make it easy to maneuver. Scaffold is sturdy welded steel within a U-frame.

Atlas Industrial Corp, 849—39th St, Brooklyn 32, N. Y.

(Continued on page 148)

FIRE PROTECTION P304

Dry-chemical pipe system, designed for automatic protection of industrial fire hazards from such installations as transformers, diesel and gasoline engines, oil-storage tanks, is operated by a heat-actuated device. When fire starts and temperature increases, air expands within this device. It trips a nitrogen-cylinder release, pressuring the dry-chemical container. Dry chemical is then discharged through strategically located distribution pipe heads into the fire area.

Ansul Chemical Co, Marinette, Wis.

COOLING TOWER P315

Compact cooling-tower unit, completely prefabricated, ready for rapid erection, featuring sturdy redwood or metal shell construction, is built in three distinctly different types: (1) horizontal flow (2) vertical flow (3) cylindrical-vertical flow.

Santa Fe Tank & Tower Co, 5401 S. Boyle Ave, Los Angeles 11, Calif.

For more data on these items, use post cards, p194a. Identify request with P and number.

piping repairs *cost more* now!

You make them less often by using Dependable Quality

CRANE VALVES

...That's why more Crane Valves are used than any other make

No. 488 Iron Body Clamp Gate

easy access prevents trouble with this valve

Remove just two nuts to dismantle this gate valve for inspection, cleaning, or repairs—without taking it from the line. Reassemble just as easily, knowing that Crane clamp design keeps the bonnet joint snug and accurately aligned. Use Crane Clamp Gates on steam, water, and air, but especially in heavy fluid lines needing periodic cleanout. They'll save time, labor, and encourage regular servicing that prevents valve trouble.

Combining easy access with highly dependable service features, Crane Clamp Gates typify Crane Quality—*better valve performance at lowest ultimate cost.*

CRANE

CRANE CO., *General Offices:*
836 S. Michigan Ave., Chicago 5, Ill.
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VALVES • FITTINGS • PIPE • PLUMBING • HEATING

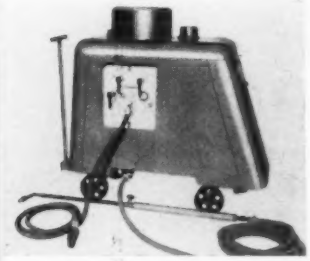
EQUIPMENT NEWS CONTINUED

CATHODIC PROTECTION P301

Underground metal pipe, or what have you, can have its life lengthened by using cathodic protection employing magnesium anodes as the "sacrifice metal." By setting up an electrical cricuit with the underground metal as the cathode and the *Anode-Pak* unit, consisting of either a 17- or 32-lb magnesium pack as the anode, the underground metal can be protected.

These *Anode-Pak* units have a chemically balanced backfill in a permeable cloth sack. A 10-ft insulated copper wire is attached so the unit is ready for instant installation in service. Its use eliminates need for mixing backfill at the site.

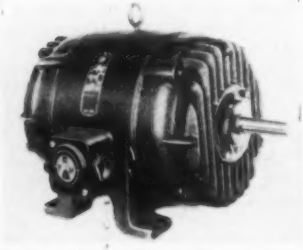
Apex Smelting Co, Chicago 12, Ill.



STEAM CLEANER P318

New combination steam cleaner and automotive cooling-system flusher, Model JO *Hypressure* Jenny, has a built-in steam *Thoro-Purge*. Combination features: (1) oil-fired, electric motor-driven steam cleaner operating at 80 to 120 psi with 90-gph capacity (2) cleaner that reverse-flushes a complete cooling system including radiator, engine block and water-type heaters in one operation.

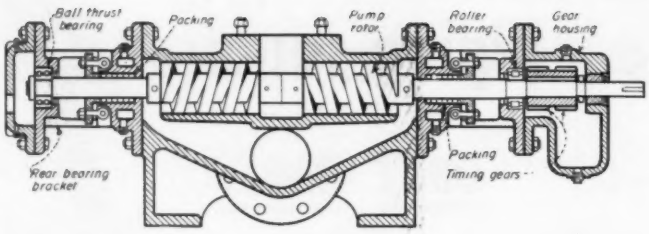
Homestead Valve Mfg Co, PO Box 210, Coraopolis, Pa.



TOTALLY ENCLOSED MOTOR P324

Line of type-QZE squirrel-cage motors now include 7½ hp, 1800 rpm, and 5 hp, 1200 rpm. Ball bearings have ample grease space to permit sealing for life of the bearing if desired. But provision is also made for easy flushing and regreasing.

Fairbanks, Morse Co, 600 S. Michigan Ave, Chicago 5, Ill.

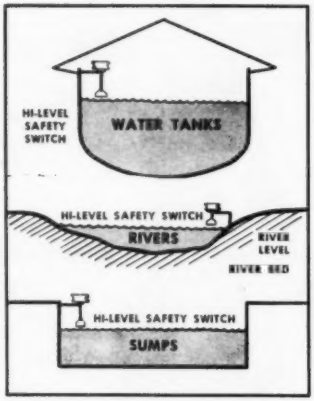


SCREW PUMP P333

An external-gear and bearing-bracket positive-displacement screw pump handles nonlubricating liquids in capacities of 1 to 700 gpm. External timing gears and bearings are in housings that form an integral unit with the pump's body. For less wear on bearings and timing gears, rotors are positioned axially and radially. A double-row contact ball bearing positions the rotor axially. Precision-cut timing gears and heavy-duty roller bearings position the rotor radially.

Pump can be direct connected to motors operating at up to 1800 rpm. It is built in vertical and horizontal constructions, in corrosion-resisting alloys, with steam-jacketed bodies and special stuffing boxes and bearings for high temperatures. Hopper bodies can be had for very high viscosity liquids.

Sier-Bath Gear & Pump Co, 9252 Hudson Blvd, North Bergen, N. J.



LEVEL SWITCH P321

Autocon Hi-Level safety switch needs but ½-in. rise in water level to operate. Unit functions by compressing air in bell chamber, which operates switch to set off either audible or visual alarm.

Since neither floats nor electrodes are used, the device is not affected by low temperatures. Simple in design, the switch is constructed with standard enclosure NEMA V and IV, and is shipped complete.

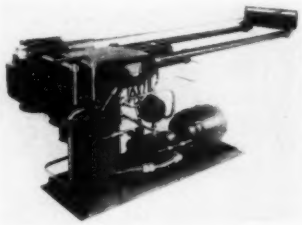
Automatic Control Co, 1005 University Ave, St. Paul 4, Minn.

FLEXIBLE HOSE P310

Stainless-steel, corrugated, flexible metal hose, fabricated from thin wall tubing with wall thicknesses of .010 in. in the ¼-in. size to .035 in. in the 4-in. size, can be used under conditions of extreme temperatures and corrosion, such as loading chemicals and acids. Normal pitch has a free flexing radius from 10 in. in the ¼-in. size to 41 in. in the 4-in. size. The close pitch has a free flexing radius from 5 in. in the ¼-in. size to 33 in. in the 4-in. size.

Nottingham & Phaneuf, Inc, 330 W 36th St, New York 18, N. Y.

For more data on these items, use post cards, p194a. Identify request with P and number.



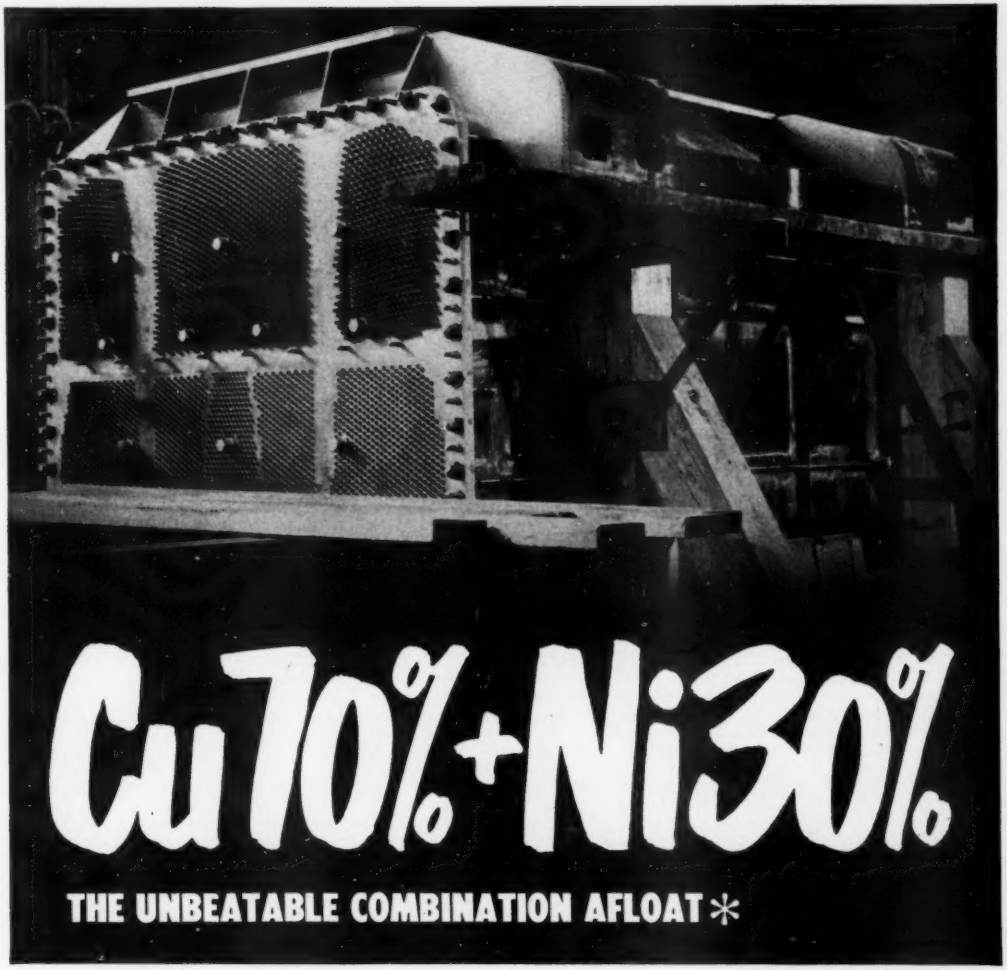
HYDRAULIC PIPE BENDER P332

Small, compact bending machine is 21 in. wide, 34 in. high and 78 in. long, has power beyond its capacity of 1¾ in. OD by No. 16 BWG steel tubing. Unit is powered by standard 2-hp, 220/440-v, 3-ph, 60-cps motor furnished with bender. Single lever operates machine. Bending die, held on by spring clips, is easily changed. It is a combination die with four different sizes, one on each side. Bender can be quickly changed from right-hand to left-hand unit.

Wallace Supplies Mfg Co, 1300 Diversey Pkwy, Chicago 14, Ill.

PIPE SEAL P312

A new material called *Anaerobic Permasil* remains liquid as long as a stream of air bubbles through it, but it hardens in a few minutes when away from air. Its properties are thus opposite to those of paint, which hardens when exposed to air.



A main condenser for MSTS Transport President Hayes in the shipyard of the New York Shipbuilding Corporation, Camden, N. J. Revere Cupro-Nickel Tubes (30% nickel) are used. The tube plates are Muntz Metal.

*AND WHEREVER ELSE CONDITIONS ARE EXTRA DIFFICULT

CUPRO-NICKEL is the preferred alloy for condenser tubes in marine use because of its superior resistance to the corrosive influences of sea and harbor water, the latter usually contaminated with extremely active industrial and sewage wastes. Thus it is natural that cupro-nickel, 30%, is being used for the tubes in three vessels now being completed by the New York Shipbuilding Corporation, Camden, N. J. These ships were originally ordered for the American President Lines, Ltd., for passenger and cargo service, but subsequently taken over for military service. The builder constructed the condensers at its yard, and Revere furnished the tubes and plates.

In addition to cupro-nickel, Revere also makes tubes and sheets in other alloys, such as Admiralty, Muntz Metal, Naval Brass, Aluminum Bronze, etc. Choice of the correct alloy depends on the conditions it must encounter. Revere will gladly collaborate with you on matters involving condensers and heat exchangers.

REVERE 150th YEAR OF SERVICE TO AMERICA

COPPER AND BRASS INCORPORATED

Founded by Paul Revere in 1801

230 Park Avenue, New York 17, N. Y.

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Mills: Baltimore, Md.; Chicago and Clinton, Ill.; Detroit, Mich.; Los Angeles and Riverside, Calif.; New Bedford, Mass.; Rome, N. Y.—Sales Offices in Principal Cities, Distributors Everywhere

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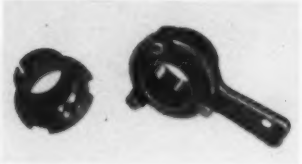
EQUIPMENT NEWS *CONTINUED*

Because this material can penetrate extremely small cracks for hardening, it is considered as possibly applying as a tight seal for threaded unions for pipe fittings. In other words, a "pipe dope." *Permasil* undergoes a chemical change called polymerization and hardens fully without the necessity of any evaporation. If, however, it is desired to have it harden faster, it may be heated up to 212 F, and solidification will take place in a minute or less.
General Electric Co, Schenectady 5, N. Y.



COUPLING UNIT P303

Two-piece self-positioning quick-coupling unit opens and closes with less than a quarter turn in less than a second. It consists of a body with three tapered locking lugs and mating male or female tailpiece or hose spud in sizes ranging from ½ to 6 in., inclusive. The coupling, called the *JS Quick*, is available in aluminum, high-test bronze, stainless steel, and Ni-Risist. Standard couplings take up to 150 psig and high-pressure models are available for pressures in excess of 2000 psig. The coupling handles gas or fluid.
Mead Cornell & Co, PO Box 2682, Cleveland 7, Ohio.

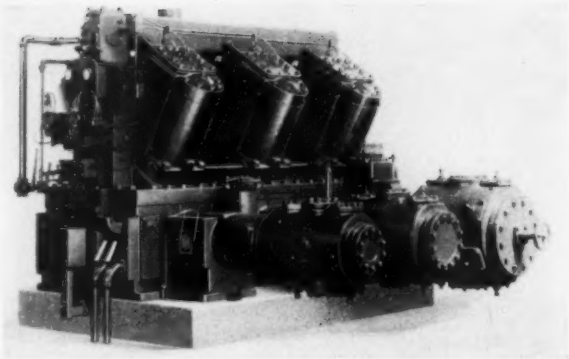
WORKING AGENT P317

Just one part of *Hydrodyne* added to one thousand parts of coolant reduces interfacial tension of the coolant. This greatly increases the cooling efficiency by assuring intimate contact with working surfaces and speeding dissipation of harmful heat. *Hydrodyne* improves any usual coolant, regardless of oils or additives used.
Aquadyne Corp, 220 E. 42nd St, New York 17, N. Y.

DISPLACEMENT METER P302

High-capacity positive-displacement meter, capable of handling gas at pressures up to 1000 psi, permits accurate metering over wide ranges of gas at the takeoff point. The new meter—the No. 2½ Rockwell meant for 1000-psi working pressure—weighs 950 lb, is encased in a high-tensile alloy casting with 1¼-in. studs joining body and cover.

Meter has capacities of 31,000 and 46,000 cfh of gas on a 4-oz basis at pressure drops of 6- and 7-in. hg. This is said to be the first time diaphragm-type meters have been made usable above 500 psi.
Rockwell Mfg Co, Valve & Meter Div, Pittsburgh, Pa.

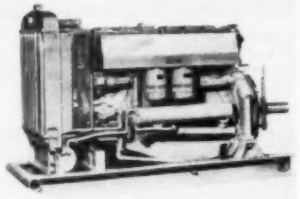


ENGINE COMPRESSOR P326

Gas-engine-driven compressor is essentially the well-known V-angle XVG but improved and modernized by complete redesign. SVG built in two sizes, 330 hp with 6 cyl and 440 hp with 8 cyl. Controls and valves grouped at operating end. Suitable for industrial air, gas or refrigeration service, these units also find many uses in petroleum and chemical plants.
Ingersoll-Rand Co, 11 Broadway, New York 4, N. Y.

PEN RECORDER P320

Speedomax 2-pen electronic unit records two functions simultaneously against time. The two separate electronically-amplified measuring circuits, two balancing motors and two recording pens are all housed in one *Speedomax* case. Circuits can be supplied to work with thermocouples, *Thermohms*, strain gages, tachometers, thermal converters, etc. Instruments can operate controls or alarms.
Leeds & Northrup Co, 4934 Stenton Ave, Philadelphia 44, Pa.



HEAVY-DUTY DIESELS P328

Six models, from 145 to 220 hp, are designed to operate at continuous speeds up to 1400 rpm. Higher operating speed makes possible application in many new services including those requiring torque-converter power transmission. Design features include true diesel operation, unit fuel injection, four valves per cylinder, hydraulic servo-type governor, etc.
Murphy Diesel Co, 5317 W Burnham St, Milwaukee 14, Wis.

For more data on these items, use post cards, p194a. Identify request with P and number.

FLEXIBLE COUPLING P335

For motors up to ½ hp, neoprene element flexible coupling reduces operating noises, absorbs torsional vibration, accommodates large shaft misalignment. Oil-resistant neoprene is bonded between two flanged hubs to form a one-piece design. Die-formed hubs are drawn with a flat on one side to form a D-shaped bore. This bore fits onto a milled flat on motor and driven shafts so keyway, pins or setscrews are not needed.
Lord Manufacturing Co, Erie, Pa.

PYROMETER EQUIPMENT P323

Designed for industrial applications that include heat-treating furnaces, brick, cement or ceramic kilns, the instrument has a calibrated accuracy within 0.75% of full scale. Indicating device is a millivoltmeter that is connected to a thermocouple on the furnace or other heating equipment.
General Electric Co, Schenectady 5, N. Y.

BIN AND HOPPER VIBRATOR P330

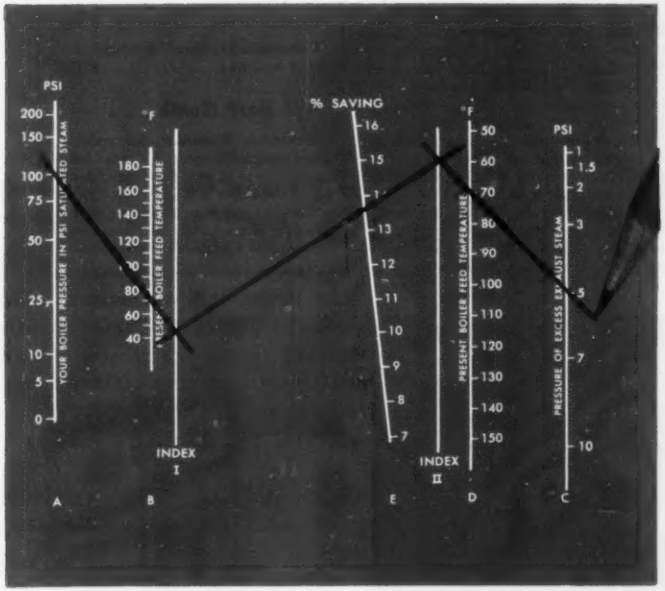
Quiet Type vibrator, style EM, is designed specially for bins, hoppers, chutes, shakeouts and other jobs. Features heavy pistons and long strokes. Available in 1⅝ to 4-in. sizes, interchangeable with any bolted-type vibrator.
Cannon Vibrator Co, 1108 Power Ave, Cleveland 14, Ohio.

PNEUMATIC CONTROLLER P307

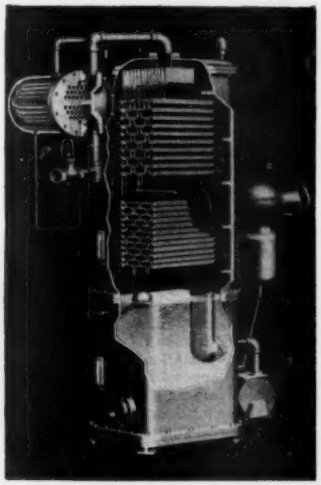
Forced balance nonindicating controller for pneumatic transmission system supplements the company's recently announced *Transaire* temperature and pressure transmitters and the miniature *Transet* recording receivers. The new controller, called *Tri-Act*, gives, in conjunction with the

Use this chart to figure fuel savings with a Swartwout Feed Water Heater

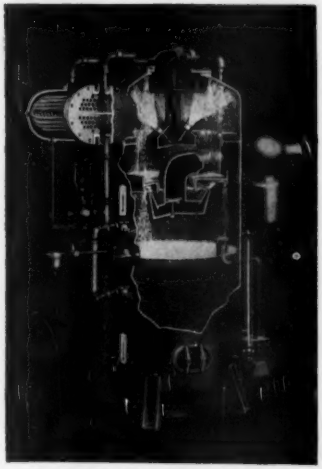
1 Here's how to figure your fuel savings with a Swartwout Feed Water Heater: Connect point on Scale A to point on Scale B and project line to intersect Index I. Connect point on Scale C to point on Scale D and project line to intersect Index II. Connect points on Index I and Index II and read percentage fuel savings on Scale E. The example given on nomogram—100 psi saturated steam boiler using 70°F feed water and 5 psi exhaust steam—shows a representative saving of approximately 13.6% of your present fuel cost.



2 By utilizing the residual heat in exhaust steam, Swartwout Feed Water Heaters can save you approximately 1% of your present fuel cost for each 11°F increase in boiler feed water temperature. In addition, you improve your boiler operation in other important, cost-cutting ways—faster steaming rate, temperature strain relief, removal by deaeration of soluble gases that cause boiler and economizer corrosion. Accessories are furnished to meet the requirements of each particular installation.



3 Swartwout cast iron or steel deaerating heaters (.03 oxygen guarantee) and deaerators (.005 oxygen guarantee) are supplied with cast iron or stainless steel trays. By using the counterflow principle the greatest degree of deaeration is obtained because the water is in contact with clean steam just before dropping into the storage section.



4 Swartwout all-steel spray heaters (atomizing type) give feed water with an oxygen content guaranteed not to exceed .005 cc per liter of water. All surfaces subjected to impingement of water are made of stainless steel. Swartwout heaters are specially engineered to your specifications.

A-3668

Swartwout

POWER PLANT EQUIPMENT

SEND FOR BULLETINS S-18-E, S-210 • THE SWARTWOUT COMPANY, 18511 EUCLID AVENUE, CLEVELAND 12, OHIO

EQUIPMENT NEWS *CONTINUED*

previously mentioned equipment: (1) faster, more accurate measurement of rapidly changing temperatures and pressures (2) closer process control with stability (3) continuous process record on a 30-day strip chart. All this information is contained in a 4⅜x5-in. miniature pneumatic receiver.
Taylor Instrument Co's, 95 Ames St, Rochester 1, N. Y.

HUMIDITY CONTROLLER P313

Plug-in humidity controller employs a humidistat of a standard human-hair type. Humidity scale is graduated from 20 to 100% relative humidity. Its dimensions are 7½ in. wide x 3¾ deep x 6¾ high. Its net weight is 3¼ lb. To put the plug-in controller to work, all that is needed is to: (1) plug the humidifier or dehumidifer to be controlled into the plug-in unit (2) plug the control unit into a wall outlet (3) set the humidity dial at the percentage of relative humidity desired. The controller can handle a load of 15 amp at 115 v. A continuous load of 1700 watts.
Abbeon Supply Co, 58-10—41st Drive, Woodside, N. Y.

HANDHOLE AND TUBECAP COVER GASKETS P331

Made of low-carbon plated steel, asbestos filler and type 304 stainless steel, these gaskets are available for practically all makes of boilers and auxiliary equipment operating at 0 to 1000 psi and above. No compounds needed, gaskets can frequently be reused if not removed from cover assemblies during outage. *Flexitallic* style T gaskets available in two thicknesses: 0.125 in. for assemblies having narrow seating surfaces and high bonding loads; 0.175 in. for broad seating surfaces and low bonding loads.
Flexitallic Gasket Co, Eighth and Bailey Sts, Camden 5, N. J.

Wait! . . . Take Another Minute to Check These

Steam-Jet Cleaning, right from existing steam-plant facilities. This high-pressure tank is mounted on all-metal dolly with rubber-tired wheels ..... p 186

Electric Cable Hoists built in ½- to 5-ton capacities have motor enclosed in cable drum to reduce weight and dimensions ..... p 188

Unit Substation designed for low-voltage lighting and power loads in industrial plants. Dry-type transformer and induction regulator are included in one steel housing ... p 190

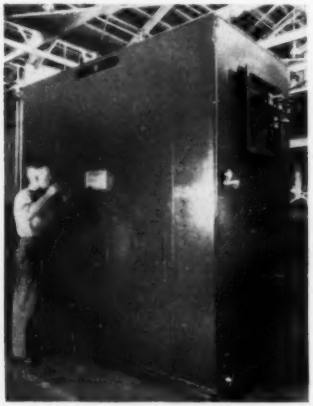
Corrosion-Resistant Fittings for tube and pipe ..... p 192

And Next Month . . .

Electronic Recorder that quickly and accurately measures rotor temperatures in large electric generators. Unit furnishes a 12-in. strip record that can serve as a guide for gradual cooling of generator. Instrument will help plant operators avoid overloads.

SPRAY GUN P309

Dry superheated steam acts as the atomizing medium for a complete line of paint-spraying equipment. The steam heats the finishing material, making it possible to use materials of higher viscosity and heavier coats without sagging or running. Difficulties of pinholing and cropping normally caused by entrapped air are greatly reduced. The S-100 steam spray gun, employing new installation and radiation design, dissipates the heat caused by the steam in the gun so it can be operated continuously in comfort with bare hands. It has a built-in finger guard.
American Brake Shoe Co, Kellogg Div, 97 Humboldt St, Rochester 9, N. Y.

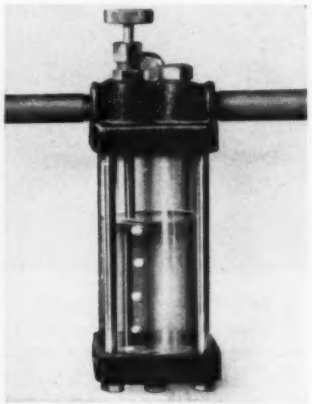


DRY-TYPE TRANSFORMER P322

Hermetically sealed unit with Class B insulation that runs but 10% higher in price than conventional open-type units. Tests in GE labs show Class B insulation in a nitrogen atmosphere can be satisfactorily operated at the 180 C temperature previously assigned only to Class H materials.

These nitrogen-filled, sealed, dry-type transformers are available in ratings up through 1500 kva and 15 kv. They can be installed indoors without fireproof vaults.
General Electric Co, Schenectady, N. Y.

For more data on these items, use post cards, p194a. Identify request with P and number.



FEED BUBBLER AND SEDIMENT TRAP P327

Sight-feed bubbler controls and visually indicates small rates of flow of air or gas. Sediment trap removes dirt and moisture from line. In bubbler, entire flow of air or gas is passed through liquid in transparent cylinder where rate of flow is shown by bubbles rising through liquid. Any liquid may be used and needle valve at top permits selection of any flow rate from less than 1 bubble per sec to about 20 cfm. Sediment trap same as bubbler but doesn't have needle valve, dip tube or filler plug. It handles maximum flow of about 6 cfm.
King Engrg Corp, Box 500, Ann Arbor, Mich.

(Continued on page 186)

ANNOUNCING
A BRAND NEW CATALOG
FOR BONNEY WELDOLETS

Contains complete and up-to-the-minute catalog information on all types of Weldolet welding fittings available. Presents a full range of sizes and schedules, introducing many new applications, together with simplified data on the determination of code requirements. To get your copy of this catalog, write . . ,

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WELDOLETS

WELDING FITTINGS FOR ANY PIPING SERVICE

What's Wrong Here?

The other night I went to a meeting of the civil-defense council in my town. We're just getting organized so much of the talk was about people. "Who can we get to head up the auxiliary police? Who'd be a good man to set up a transportation detail?" And so it went.

As we wrestled with the job of finding good men for the many chores in such a program I began to feel in a vague sort of way that something was missing. At first I couldn't put a finger on it. It kept nagging at the back of my mind until I figured out what it was.

Looking around, I could see all the local doctors, most of the town officials, a good group of our merchants and business men. But I began to feel lonesome because as I ticked off the familiar faces I didn't see more than one or two from our local industries.

Now our town isn't an industrial center. We're fairly close to a big city, though. And we've got a number of small plants of our own. So we have a pretty large number of engineers, production men and managers living in our community—some working right here, many commuting to the big city.

I realize that with war production going into high gear, these people are plenty busy. I know I am. And I also recognize that when it comes to civil defense, these industrial men have a responsibility in their own shops. Industry has got to see to the safety of its people and the protection of its facilities.

Yet these are the men the community needs, also. We've got a little electronics plant in town, for example. Bill Fraas, chief engineer there, really knows his way around in that game. We could use his brains when we plan an emergency communications setup.

Jack Stephens, a top insurance-company fire-protection expert, ought to be sitting in with our auxiliary firemen. For any kind of an organizing job, Ben Parker, manager of our biggest local plant, would get the nod if I were running the show.

And so it goes. In the very nature of things, industry's ranks include the technical skills and the organizing savvy the civil-defense program needs. How can we bring them into this job without overloading the willing horses?

I know what I'm going to do about it. My assistant at the plant is a smart youngster and I've been grooming him to take over when I retire. It'll be good for him to head up the plant-protection end of it, while I pitch in with the community program.

In some other plants it may work out the other way. Maybe the No. 1 man will want to put one of his assistants to work on community defense. However it's done, the need is clear. Civil-defense calls for the kind of know-how we in industry have. It's our clear duty—yours and mine—to find a way to make it available. Let's get in there and pitch!

George Edwards

Engineer

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A new improved tank lining!

saran rubber*

better corrosion resistance
easy, economical installation

Dowell saran rubber has proved to be a superior material for lining tanks. Developed by The Dow Chemical Company and now distributed and applied by Dowell, it has found growing acceptance as a lining for storage tanks, production tanks, tank cars and trailers, processing equipment, pipes and fittings. Ten years of extensive testing have shown that Dowell saran rubber provides a practical method for cutting corrosion costs.

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Dowell, for many years a leader in plant maintenance services, is not only a source of supply for saran rubber, but also offers expert application service or engineering instruction for installation by your own personnel. Get the facts on this new anti-corrosive tank lining and on Dowell Service. Send in the coupon below.

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ROTOJET Motor has only two moving parts, a shaft and a paddle. Positive contact between paddle and Rotocentric (egg-shape) bore cylinder prevents stalling at low speeds. No leakage. Delivers maximum power for air used.

Rotojet owners can expect little or no maintenance problems during the critical times ahead. Simple design has always been a basic feature of Rotojet Motors, which have only two moving parts. That is a very important advantage, especially when quality materials for replacement parts are in short supply.

Replacement parts have always been available for Rotojet Cleaners. During our 40 years of tube cleaner specialization, prompt, efficient service has earned us the good will of our thousands of customers. To help owners of old and new Rotojet equipment to get maximum service, we have prepared a folder showing various accessories which will prolong the life and improve the performance of tube cleaners. We invite you to write for a free copy.

SEND FOR NEW ROTOJET BULLETIN

ELLIOTT COMPANY-ROTO DIVISION

153 Sussex Avenue Newark 1, N. J.

TECHNICAL BRIEFS

(*Continued from page* 138)

In the power industry aluminum tubes are being used in tubular air pre-heaters or boilers. Here, flue gases, often highly contaminated with sulfur compounds, heat air before it is used to fire the boiler. *ASME paper, No. 50-A-123.*

Directions for ordering papers on p 138

Fuels and Firing

RADIANT-GAS BURNERS, *by J C D Keller, consulting engineer.* Radiant or "surface combustion" gas burners were introduced about 1912. About nine years ago the radiant-gas burner came back into the picture. There was such a scarcity of data on operation and other factors that a research project was set under way. Its objects were to (1) test various types of industrial radiant burners available (2) determine their capacity, radiating efficiency required, mixed pressure needed, and operating characteristics (3) develop, if possible, radiant burners at higher specific capacity with greatly increased radiating efficiency. It was hoped the burners would be capable of operating with an inspirator and inducing required combustion air from the atmosphere without need of a blower.

The author discusses the various burners tested, the decision to follow two distinct lines toward producing improved burners, and shows test methods and apparatus. *ASME paper No. 50-A-59.*

COMBINATION SPREADER STOKER AND WASTE-FUEL FURNACES, *by F C Messaros, American Engineering Co.* Combustible wastes have been receiving more and more attention as a possible fuel for power generation. As the cost of basic fuels increases, more methods are devised for burning these relatively cost-free wastes. At the same time, it gets rid of a costly disposal problem. Many of the waste products, such as coal dust, coke breeze, black liquor, wood waste, are so well known today that their use is made a part of the normal power generation of their industries.

The author deals with the successful combustion of scrap resulting from the manufacture of self-based floor covering. The decision was reached to provide a 2-stage furnace, one stage of which would be charged with scrap, and the other with coal. It was felt such an arrangement would give an initial gasification and partial combustion of the scrap in the first stage, and combustion of these gases would be completed in the second stage. The

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The tractor method of handling coal is considerably more economical and flexible than complex conveyor or crane systems . . . both in first cost and in operation. It permits keeping equipment investment in close balance with current operating needs at all times. As demand increases, more tractor units can be added. Or storage areas can be abandoned without leaving money tied up in idle stationary equipment.

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Allis-Chalmers Torque Converter Tractor equipped with hydraulic bulldozer stores coal at a large Pennsylvania utility.

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GREATER FIRE PROTECTION

When A-C Tractors store your coal, they spread it out in thin layers and compact it by constant travel over the pile. Tight packing of horizontal layers eliminates flues that cause spontaneous combustion in loose conical piles.

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With Allis-Chalmers Tractors, you can store coal wherever you have available space and reclaim it whenever needed. These versatile A-C crawlers — equipped with loaders, bulldozers or scrapers — make their own "roadways" . . . anywhere. Use them to handle all your storing and reclaiming, or to supplement existing facilities.

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gases of both scrap and coal would then enter the common boiler. It was also recognized that adequate furnace volume and turbulence should be provided to control smoke.

Considering the pioneering involved, surprisingly few serious problems are reported. CO_2 of about 12 to 13% at the boiler outlet can be maintained, except when scrap-burner doors are open. Here the onrush of air reduces the CO_2 to 6 or 7%. The combustible content of the scrap refuse is about 5 to 8% and of stoker refuse 7 to 14%. *ASME paper No. 50-A-63.*

Directions for ordering papers on p 138

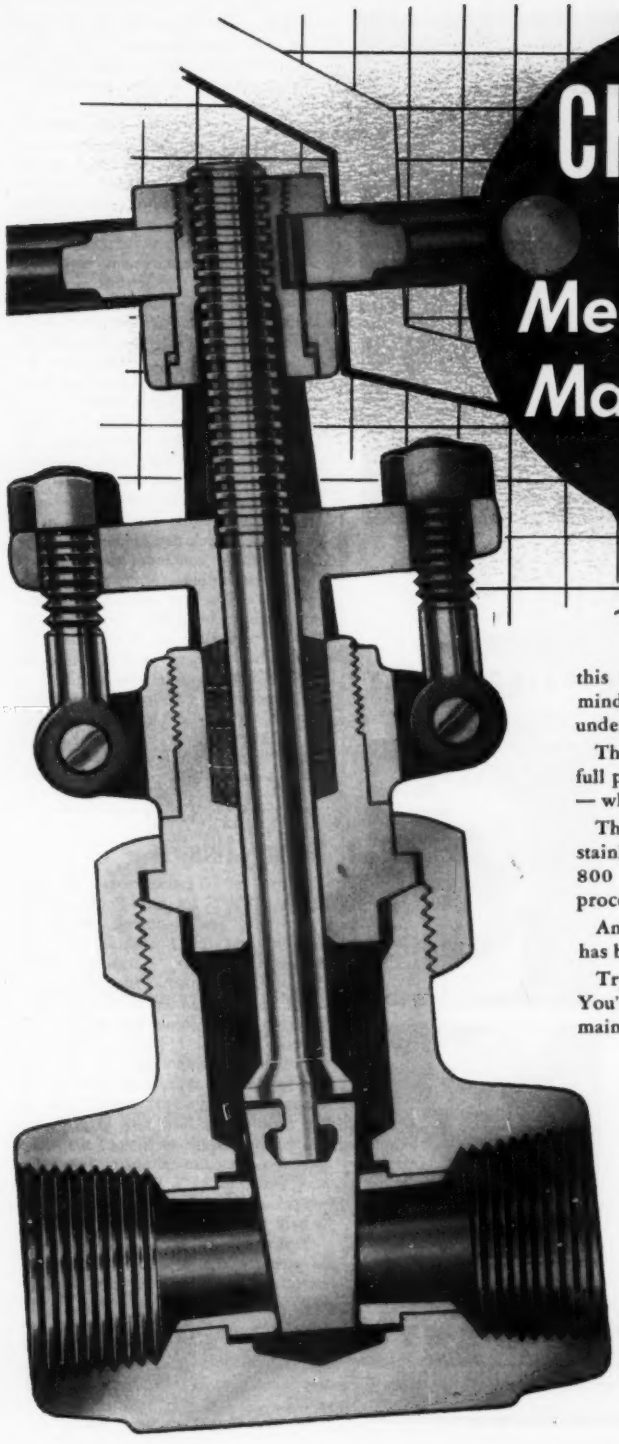
SOME ASPECTS OF THE APPLICATION OF RESIDUAL OILS AS FUEL FOR THE GAS TURBINE, *by C F Kottcamp and L O Crockett, Gulf Oil Corp.* At its present stage of development, the gas turbine seems to be commercially available in the 1000- to 10,000-hp range. In this range the gas turbine must economically justify itself in comparison with other available prime movers. High among the factors to be considered are fuel costs.

The author describes the development of residual oils in the typical refinery and discusses some of its properties. Application of No. 6 fuel oil to the combustion process of gas turbines is primarily that of fuel-oil atomization and combustion chamber design. Because it is necessary to cool gaseous products of combustion and most metal components to temperatures from 1200 to 1500 F, (a temperature range below that of molten slag from oil ash) no slag forms.

Corrosion effect of the oil ash in the turbine, however, has been charged to vanadium pentoxide components as the largest single contributor. But more test data and operating experience are necessary before the limiting amount of vanadium can be established. *ASME paper No. 50-A-131.*

REVIEW OF CONTROL OF AIR POLLUTION IN THE *U.S., by J F Barkley, U.S. Bureau of Mines, Department of the Interior.* After about a century of air - pollution - prevention problems in this country, with about half the time covering periods of considerable activity, the question naturally arises why progress has not been greater. Chief characteristic of the solution of this class of problem has been its varying nature—a series of ups and downs in community interest and enforcement. Basic reason for the cycle is indifference to or lack of fear of polluted air. The fact that we take in perhaps three to five times more pounds of air per day than food, and perhaps ten times more than water, is overlooked.

The author describes the origin of



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LIST 960
Means Lower Maintenance Costs

Chapman engineers designed this valve with your maintenance problem in mind. They've made it *tough*, so it will stand up under severest service — but *easy* to maintain.

That's why you can repack this List 960 under full pressure. Seat rings replaced quickly, easily — when necessary.

The reason, too, why seat rings are hardened stainless steel and wedge faces are hardened to 800 Brinell by the exclusive Malcomizing process.

And why the stem and wedge gate connection has been made 50% stronger than ever before.

Try it! Make your own maintenance checks. You'll find the Chapman List 960 means lower maintenance costs.

Available in sizes from ¼" to 2". Either metal to metal or gasketed joint, as required. Rising stem with yoke (as illustrated) or rising stem inside screw type. For pressure range 2000 lbs. at 100 deg. F., 380 lbs. at 1000 deg. F. Specify List 990 for higher pressures.

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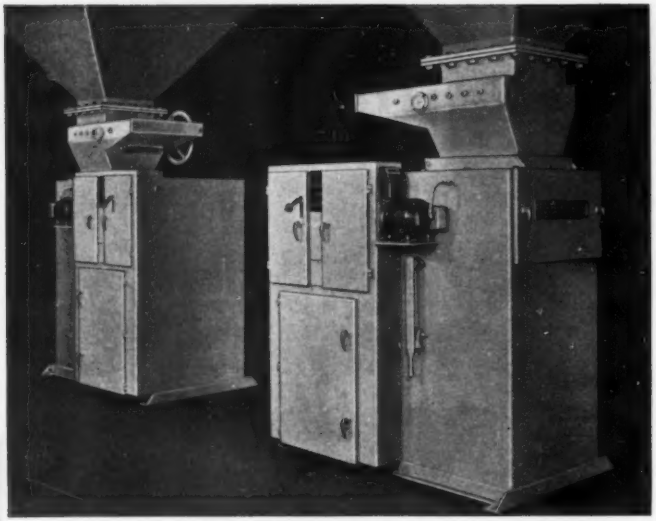

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S-E-Co. Scales are equipped with a specially designed by-pass which is very easy to operate. The operator has only to press down the latch with his thumb and then to swing the by-pass lever to the opposite position, all as shown in the photographs. To close the by-pass, he reverses this procedure.

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air-pollution ordinances in the U.S., how they have developed from community scope to county scope. Included is discussion of enabling ordinances.

The actual mechanics of an air-pollution ordinance have been discussed by a number of technical societies, and as such the ASME published an information bulletin entitled, *Example Section for a Smoke-Regulation Ordinance*. The author goes on to discuss the various emissions prohibited and standards of measurement employed. The latest work on setting of limitations has been advanced by the Air Pollution and Smoke Prevention Association. In general, it has appreciably higher or easier dust limitations for small plants and lower ones than those of the ASME for larger plants.

The only method to date of determining dust emission is included in the *ASME Test Code for Dust-Separating Apparatus*. The test requires equipment, trained personnel, time and money not normally available for many city smoke-regulation departments.

The author concludes with remarks like the following: "Many of the facts involved are variable and indeterminate. An attempt to define the extent of losses, regardless of the manner in which they arise, at once discloses the lack of definite or reliable standard of measurement." This quotation is lifted from a 1926 report covering Bureau of Mines investigations at Salt Lake City. *ASME paper, No. 50-A-126.*

Directions for ordering papers on p 138

Steam Jets

EFFECTS OF TEMPERATURE OF ENTRAINED FLUID ON THE PERFORMANCE OF STEAM JET EJECTORS, *by W C Holton and E J Schulz, Battelle Memorial Institute, Columbus, Ohio.* The Heat Exchange Institute sponsored an investigation of the performance of small commercial single- and 2-phase steam-jet ejectors handling air and steam at temperatures up to 1000 F. The results of tests are stressed in terms of "entrainment ratio." This is the ratio of the flow rate of gas at a given temperature to that of the same gas at a base temperature. The ratio was found to be a linear function of temperature. Accuracy of these results is held to plus or minus 4%.

Test results appear to be independent of pressure and of design characteristics of the ejectors under test. For that reason, the plot of the variation of entrainment ratio, with temperature, is thought to be applicable to any ejector system within, of course, limits of the test accuracy. *ASME paper No. 50-A-115.*

(*Continued on page* 164)

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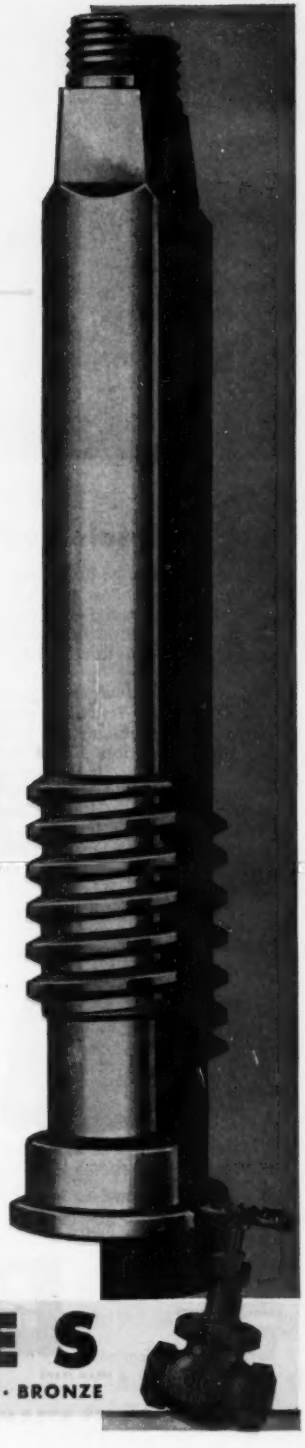

Months ago, we introduced Alloy 40 to the field; use has confirmed our laboratory tests. Now, we are ready to tell you about it.

Alloy 40 completely eliminates galling and seizing. It is harder and stronger. It is highly resistant to attack by corrosive liquids and semisolids. It lasts longer!

All OIC Bronze Valves are now equipped with Alloy 40 stems. The Ohio Injector Company, Wadsworth, Ohio.

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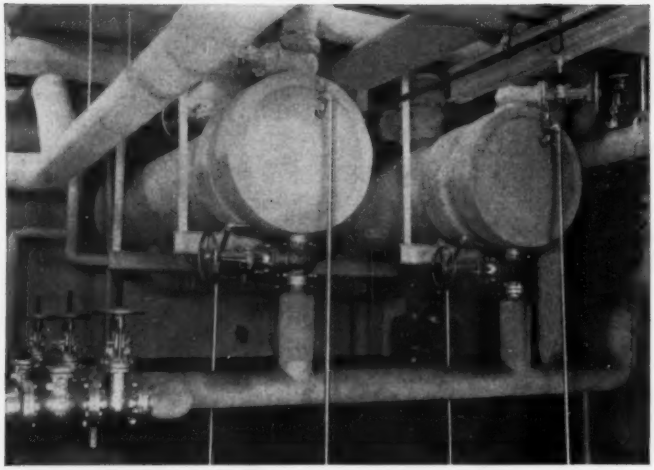

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● It's the job to be done that determines the selection of the proper heat exchanger. Few heat transfer problems are exactly alike and many require special engineering to achieve optimum results. Production is too important these days to permit inefficient operation and needless shut-downs. Insist on equipment built for the job and built to last.

ADSCO has always recognized the need for "tailoring" the equipment to the job. Its engineering department is constantly analyzing heat transfer problems and "job-selecting" the proper heat exchanger for the application. Every recommendation is backed by seventy years of experience in designing, manufacturing and installing steam equipment. Because ADSCO makes all types of heaters in a wide range of sizes, it can deliver the heat exchanger best suited for specific operating conditions.

Consult your ADSCO representative or submit your heating or cooling problem direct for a factory recommendation and quotation.

INSTANTANEOUS WATER HEATERS are furnished as either steam tube or water tube types. Commonly used as instantaneous heaters, booster heaters, convertors, pool heaters or economizers.

STORAGE HEATERS of welded construction in vertical and horizontal types. Removable U-tube element. Wide choice of materials. A. S. M. E. Code stamped when required.

FLOAT HEAD HEAT EXCHANGERS (Also shown in installation picture above) can be furnished with removable tube bundle and with split clamp ring construction for float head. Complete range of sizes to meet all specifications.

AMERICAN DISTRICT STEAM COMPANY, INC. • North Tonawanda, N.Y.

EFFECTS OF MOLECULAR WEIGHT OF ENTRAINED FLUID ON THE PERFORMANCE OF STEAM JET EJECTORS, *by W C Holton, Battelle Memorial Institute.* Manufacturers and users of steam jet ejectors have long been faced with the problem of specifying correct ejector size to pump a gas whose properties differ widely from air. The Heat Exchange Institute sponsored a program of research involving 12 pure gases and 12 mixtures of gases with small commercial single- and 2-stage steam jet ejectors.

Results were calculated in terms of "air equivalent," or "entrainment ratio." This ratio is the one between flow rate of gas to that of air under similar conditions. These ratios were found to be a function of molecular weight of gases handled and were plotted as a smooth curve independent of pressure and design characteristics of ejectors and apply as well to mixtures of gases. Tables are given showing the composition of the various gases used, their molecular weight, and the different mixtures employed in the tests. *ASME paper No. 50-A-114.*

MEASUREMENT OF FLOW RATE IN SATURATED AIR TEST FOR STEAM JET EJECTORS, *by R C Binder, Purdue University.* The weight rate of fluid entering an ejector suction as a measure of its capacity is an important performance characteristic. Its measurement is of concern to both users and manufacturers. The problem of standardizing a simple practical industrial test is, of course, difficult. This paper discusses possible errors in measuring the flow rate in saturated air tests of steam ejectors. In some cases a small error in temperature may mean a large error in flow rate.

While an accurate test can be devised, it involves such instrument complications that it is not practical from an industrial viewpoint. It is hard to control saturator test equipment. A suggested solution to this problem of flow measurement is a test with dry air (or air and superheated vapor) for each stage, and a test of the intercondenser between stages. This type of test is reliable and fairly accurate without imposing too great a problem. *ASME paper No. 50-A-47.*

Directions for ordering papers on p 138

ELECTRONICS

(*Continued from page* 126)

In the meter's top are two flat coils RC_1 and RC_2 located at pump cut-in points. Impedance of these coils increases as the armature passes into them and is picked up by thyratrons T_1 and

Eagle-Picher Insulation can help you get maximum heat and power from each fuel dollar expended

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EAGLE-PICHER DE-85 BLOCKS

A highly efficient, rigid-type insulating material composed almost entirely of pure, lightweight, Eagle-Picher Diatomaceous Earth. High physical strength enables these blocks to stand up under usage normally encountered in installation. Adaptable to virtually all types of heated equipment. Can be cut with a knife, or sawed, to fit irregular shapes. DE-85 Blocks for temperatures to 1300°F. DE-95 Blocks for temperatures to 2000°F.

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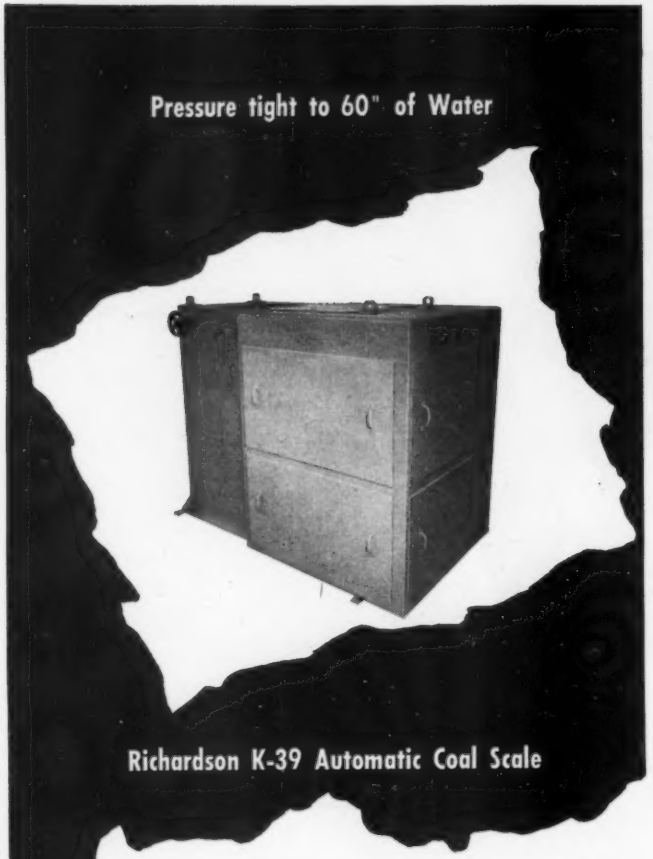

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Bulletin No. 0250 gives complete details on how and why the Richardson K-39 Automatic Coal Scale means more efficient and economical fueling. Write for it today—or ask a Richardson Engineer to survey your present methods of checking on fuel consumption. There's no obligation.

Richardson

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T_3 to start the proper pump motor.

Grid Bias. When the armature is not in coil RC_2, resistors R_4, R_5, R_6, capacitor C_2 and coil RC_2 form a network that holds a minus bias on the control grid of tube T_2. Likewise, resistors R_1, R_2, R_3, capacitor C_1 and coil RC_1 hold a minus bias on tube T_1 and these tubes cannot conduct. When the armature rises into coil RC_2, its reactance increases to a value that practically blocks its circuit. This causes tube T_2 to conduct and close relay B_2.

Sequence Switch. This switch, at top of Fig. 3, permits starting the pump in different sequences. Chart in upper right-hand corner shows contacts that close for each position of the switch. Crosses under the switch positions indicate closed contacts. When the switch is in position No. 1, contacts $1 + 1C$, $4 + 3C$, $6 + 5C$, and $8 + 7C$ close. These are shown closed on the diagram by short diagonal lines. With the switch in this position, the two pumps are on automatic control, No. 1 starting first.

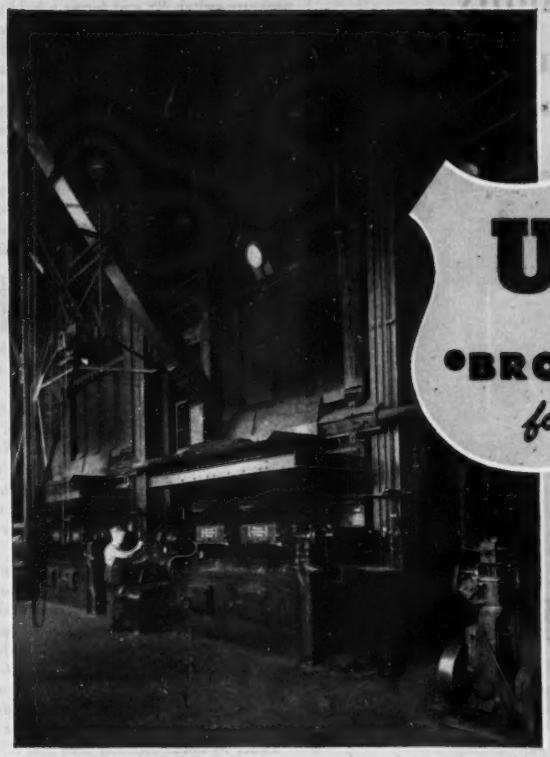
Position No. 2 of the switch starts the pumps in reverse order, as shown at bottom of chart. Switch position No. 3 gives manual control of the two pumps, where positions No. 4 and 5 each control a single pump manually; No. 6 is off.

Starting Pump No. 1. Assume (1) sequence switch is on position No. 1, (2) motor power switch is closed and (3) pressure drops in the liquid line so pressure switch PS closes. A circuit is completed from line A to $5C$ on the sequence switch to 6, primary of transformer PT_1, to $7C$, down to line C. Secondary ST_1 energizes primary PT_2 so secondary ST_2 heats the cathodes of thyratrons T_1 and T_2. These circuits are from ST_2 through the cathode heaters back to ST_1.

Coil RT of delay-release timer is energized from D on ST_1 through the coil, contacts PS on the pressure switch, back to ST_1. Coil RT closes contacts RT_1 and RT_2 in the delay-release timer. Contact RT_1 connects timer M, directly across ST_1. Contact RT_2 closes a circuit for the coil of voltage-transfer relay No. 1. This circuit is from D through the relay's coil to $1C$, RT_2 to ST_1.

Closing relay contact VT_1 completes a circuit through No. 1 pump-motor starter coil MS_1. This circuit is from line A through contact VT_1, the overload contacts, coil MS_1 to line B. Contacts M_1 close to connect the motor directly to the line to start pump No. 1. Contact PL_1 also closes to connect the left-hand pilot light to lines A and B to show the pump motor is on the line.

As flow increases, the float in meter OM rises. When flow has increased to where the meter's float moves its armature up into coil RC_2, tube T_2 fires. This tube conducts from F_2 cathode to anode of T_2, through relay coil B_2 to



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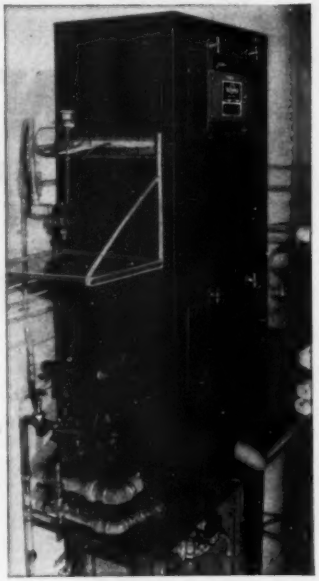

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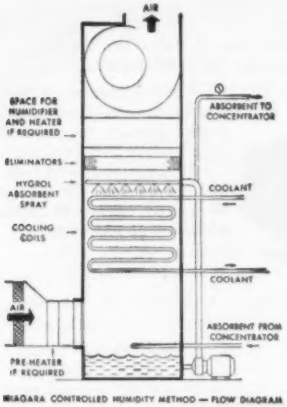

NIAGARA CONTROLLED HUMIDITY METHOD — FLOW DIAGRAM

Write for Bulletin 112

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ST_1. Contact of B_2 closes and bypasses pressure-switch PS and forms a holding circuit for coil RT of the delay-release timer, from B_2 down to H and to ST_1.

Starting Pump No. 2. If flow increases until the meter's float lifts the armature up into coil RC_2, tube T_1 conducts to energize relay coil B_1. This circuit is from G, cathode to anode of T_1, coil B_1 to transformer secondary ST_1.

When B_1 relay's contact closes, it energizes No. 2 voltage-transfer-relay coil. This circuit is from D, No. 2 relay coil, $3C$ on the selector switch, contact of B_1, to ST_1. When VT_2 contact closes it completes a circuit for coil MS_2 on No. 2 pump-motor starter from line A, VT_2, contact, down to the overload contacts, coil MS_2 to line B. Starter contacts M_2 close and start pump motor No. 2 to supply the increased flow demand.

Contact PL_2 also closes to light the right-hand pilot light to show that No. 2 pump motor is on the line. Pump No. 2 remains in service as long as flow is high enough to hold the armature up into coil RC_1. When flow decreases to where the float's armature comes down out of coil RC_1 No. A stops.

Delay-Release Timer. At petroleum-loading stations, flow may be reduced to a low value or stop for short periods and start again. Under these conditions, the float drops in the meter and the armature comes down out of coil RC_2. Tube T_2 ceases to conduct, contact of relay B_2 opens and breaks the circuit of coil RT in the delay-release timer.

Timer M holds contacts RT_1 and RT_2 closed for 1 to 2 min. Contact RT_2 remaining closed completes a circuit for voltage-transfer relay No. 1 coil and its contact VT_1 remains closed. Coil MS_1 stays energized to hold No. 1 motor on the line. If flow remains low or stops for more than the timing period of the delay-release relay, this relay opens and shuts down No. 1 pump. When flow again starts, pump No. 1 will be started on the pressure switch.

Starting Pump No. 2 First. If the selector switch is moved to its No. 2 position, it closes contacts $2 + 1C$ and $3 + 3C$. Contacts $6 + 5C$ and $8 + 7C$ remain closed as for position No. 1. Closing contact $2 + 1C$ completes a circuit for voltage-transfer relay No. 2 coil from D through the coil contact $2 + 1C$, contact RT_2 to ST_1. Closing contact VT_2 provides a circuit for coil MS_2 on No. 2 motor starter to start pump No. 2.

When flow reaches the set value, the flowmeter's armature enters coil RC_2 and tube T_2 takes over control of No. 2 pump motor, as it controlled No. 1 pump motor on No. 1 position of the selector switch. After flow exceeds a given value, No. 1 pump is brought into service to help supply the demand.

(*Continued on page* 170)

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NEW DIESEL

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NEVER BEFORE *have these Contradictory Characteristics been combined in one diesel engine*

MOVABLE Can be mounted on welded steel skid base for easy moving.	*but*	**NOT Automotive Type** Built for continuous, full-load operation.
LOW WEIGHT Low transportation, rigging and maintenance costs.	*but*	**Moderate Speed** 900-1000 rpm.
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HIGH FUEL ECONOMY 0.40 lb fuel per hp-hr means sustained low operating costs.	*but*	**Small Pistons** 7" bore x 8¼" stroke.
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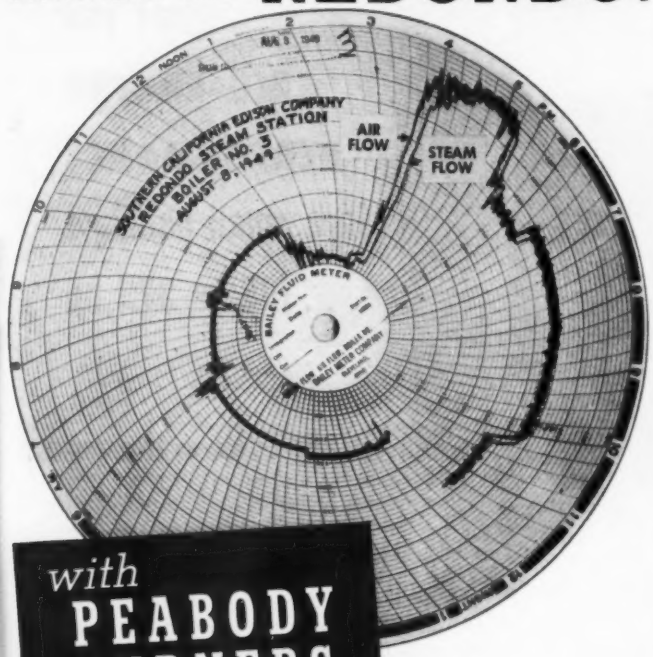

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From what we have learned of the circuits for automatic control we can easily work out those for manual control. Diagram is for two pumps. But the control can be arranged for three or more pumps by selecting the correct sequence selector switch, a flowmeter with a coil for each pump and an equal number of thyratrons in the electronic circuits.

REFRACTORIES

(*Continued from page* 109)

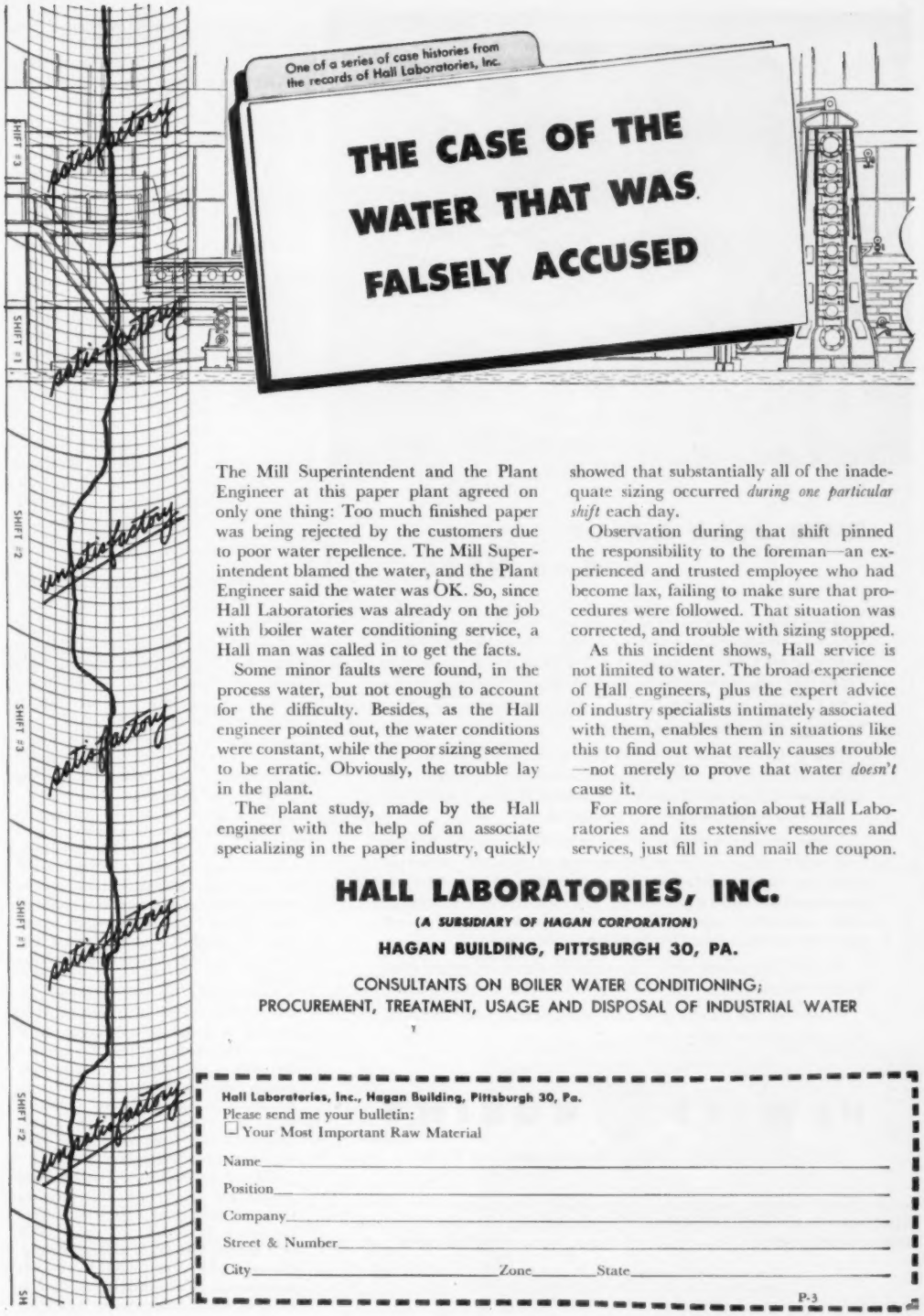
fired at a low rate for a specified number of hours depending on size and shape. This hardens or sets the refractory by baking it on the furnace side. The hot face on any extensive area is usually scored every few feet to allow expansion and contraction.

Heat transfer of plastic refractories depends on their composition. Their conductivities, in general, vary with weight or density of the material. They are especially adaptable to furnaces operating at high temperatures. In fact, furnace temperature must be high enough to harden the material. For temperatures below this level, castable refractories are used in conjunction with the plastic type. Manufacturers should be consulted to determine how these should be applied to a particular boiler furnace.

Air leaks into furnace and gas passages through cracks or imperfect joints. Monolithic construction with plastic refractories insures a structure with a minimum number of openings allowing unwanted flows into or out of the furnace and boiler gas passes.

Resistance to corrosion and erosion primarily depends on choosing the correct refractory composition for given furnace conditions. Here again monolithic construction gives fewer points and joints where destructive action might start. Refractory composition must resist disintegration from chemical and catalytic action, expansion, vitrification. Specific destructive actions also include slagging, which causes a fluxing action working on the ceramic bonding material, abrasion from flue-gas solids or from fuel beds on moving stokers, and spalling caused by uneven heating and cooling of the hot surface.

Normally the only mechanical strength that a refractory need develop is to carry its own weight. Refractory linings are usually in the form of large extensive panels, their thickness being very narrow compared to the height. In a high wall there is more danger from buckling than failure from crushing, even though monolithic construction is a stiff form of structure. Usual practice ties the monolithic panel to the supporting outer brick wall or steel



The Mill Superintendent and the Plant Engineer at this paper plant agreed on only one thing: Too much finished paper was being rejected by the customers due to poor water repellence. The Mill Superintendent blamed the water, and the Plant Engineer said the water was OK. So, since Hall Laboratories was already on the job with boiler water conditioning service, a Hall man was called in to get the facts.

Some minor faults were found, in the process water, but not enough to account for the difficulty. Besides, as the Hall engineer pointed out, the water conditions were constant, while the poor sizing seemed to be erratic. Obviously, the trouble lay in the plant.

The plant study, made by the Hall engineer with the help of an associate specializing in the paper industry, quickly showed that substantially all of the inadequate sizing occurred *during one particular shift* each day.

Observation during that shift pinned the responsibility to the foreman—an experienced and trusted employee who had become lax, failing to make sure that procedures were followed. That situation was corrected, and trouble with sizing stopped.

As this incident shows, Hall service is not limited to water. The broad experience of Hall engineers, plus the expert advice of industry specialists intimately associated with them, enables them in situations like this to find out what really causes trouble—not merely to prove that water *doesn't* cause it.

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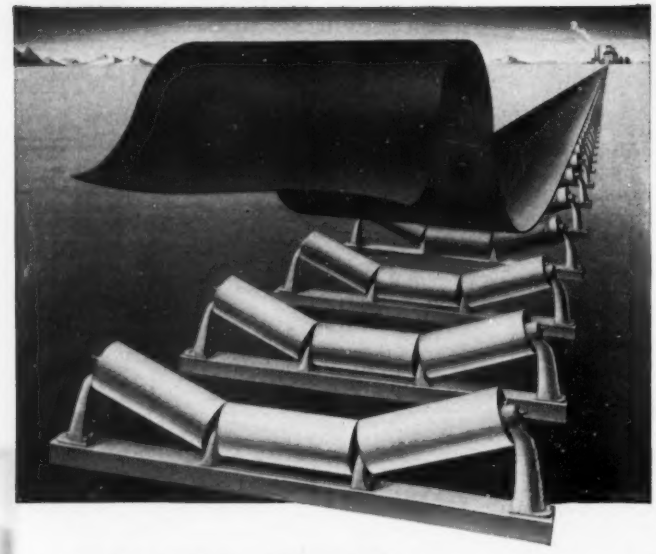

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Today, Hewitt-Robins is unique in another respect. It is the only organization in the world having, within one corporate structure, the complete belt conveyor "package": engineering, specialized machinery *and belting*. Only Hewitt-Robins can assume undivided responsibility for all the elements of a belt conveyor system; *only Hewitt-Robins makes them all.*

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Hewitt-Robins is participating in the management and financing of Kentucky Synthetic Rubber Corporation

structure by anchors distributed over the area.

For high walls, as in larger watertube boilers, brackets fastened to the boiler steelwork or to the outer brick wall sectionally support the refractory wall. This prevents overloading any part of the refractory wall and causing failure. The sectional-support arrangement adapts very easily to form an air-cooled wall for boilers without waterwalls.

Both anchors and brackets allow the refractory to move as it expands and contracts. This arrangement does not impose added strains on the monolithic construction that might cause it to crack, yet the needed support is always there. Proper installation of plastic refractory pays attention to achieving a uniform density in the wall or floor. This aids in realizing an even distribution of expansion and contraction movement through the whole structure and avoids imposing needless strains. Usually the cooler side of a plastic refractory wall never completely hardens, which gives the wall added flexibility and helps insure tightness.

Centrifugal Compressors

(*Continued from page* 115)

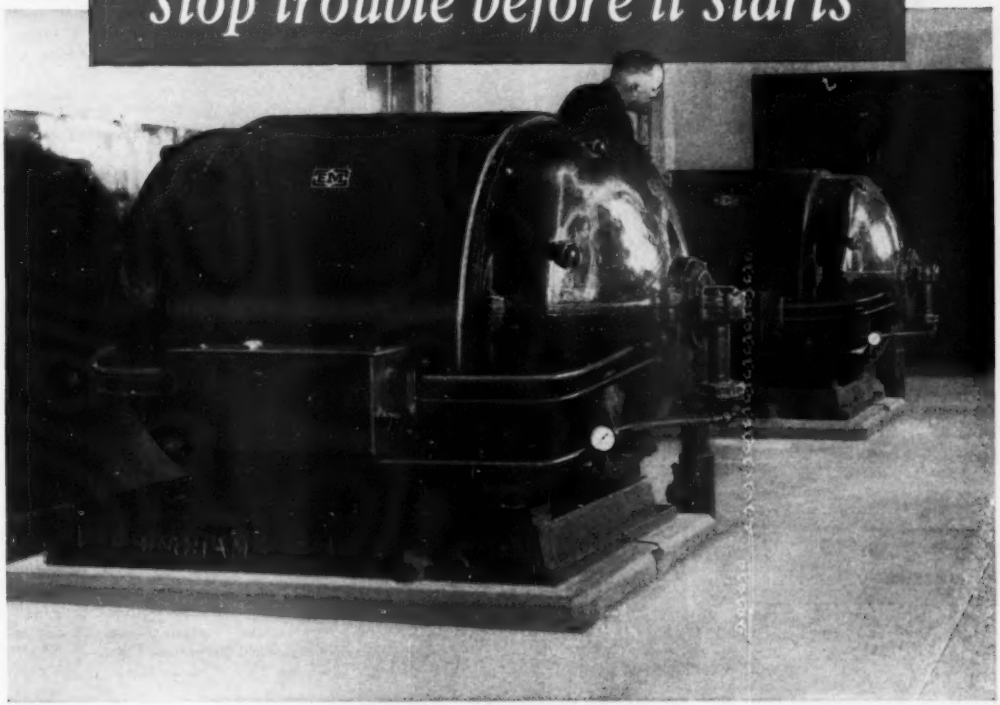
► DIAGRAMS AND CAPTIONS, pp 114, 5, summarize five of seven major components. Besides these we have a drive and controls. Since they vary with the job, we'll take only a short look at them now; in later articles we'll give more details. This, the first, is just a quick review of what happens inside a centrifugal unit while it's lapping up Btu's, day after day.

Drive. Since steam turbines operate at same high speeds as compressors they are an ideal drive. Direct connection is used; speed control and variation is simple and close. Low-pressure waste steam is often used in a condensing turbine. Or high-pressure steam may be supplied to backpressure turbine, exhausting to process and heating mains.

Synchronous motors, though constant speed, can be fitted with an eddy-current or hydraulic clutch for variation of compressor speed. Electrically, this motor has advantages, improving power factor and receiving rate consideration in some localities. Induction motor is constant speed, can be arranged to vary compressor speed with eddy-current or hydraulic clutch.

Slipring motors with resistance speed control are often used for variable-speed electric drive. Electrical losses for speed reduction are small. This isn't always realized because centrifugal-compressor characteristics are not well known. When compressor load is reduced, speed reduction for balancing

5 Extra Value Features... *stop trouble before it starts*



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E-M Heavy Duty 2 Pole Induction Motors, 800 hp. drive centrifugal pumps in a pipe line station at Drumright, Okla. Motors are started full voltage through E-M Hi-Fuse Controls.

Let's check the E-M features that stop trouble before it starts, guard against motor troubles and promote continuous operation . . . each a big step toward the elimination of shut-down.

I. **Fortifying the Coils against Moisture.** The completely wound stator is dipped in a flexible thermo-setting varnish . . . and then baked. Multiple coating and baking provide the type of protection operating conditions require.

II. **Vacuum-Pressure Impregnation** of the coils on large 2 pole motors with asphaltum insulating varnish. Result . . . finest high-voltage insulation . . . high di-electric strength . . . best seal against moisture.

III. **Choice of Flood Lubrication Systems.** E-M 2 pole motors using flood lubrication are available with a worm-gear driven pump or a separate motor-operated pump.

IV. **Shakeproof Vent Spacers.** Laminations of the rotor and stator are separated with vent spacers to provide air cooling of the motor. E-M spot welds these vent spacers . . . and increases this security with a mechanical lock.

V. **True, Uniform Air Gap.** By mounting bearing brackets above the centerline, E-M compensates for the clearance in journal, shaft and housing fits.

Write for "ABC of Large Induction Motors", the E-M 32-page bulletin that presents important information on big drives.

It will also give you some idea of why Electric Machinery of Minneapolis is known as "Specialists in Big Motor Engineering" and how this *high degree of industrial specialization* pays off for specifiers and users of E-M Big Motors, Generators and Controls.

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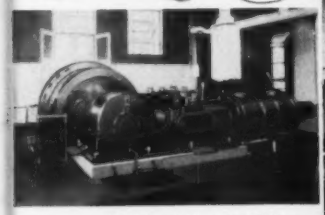
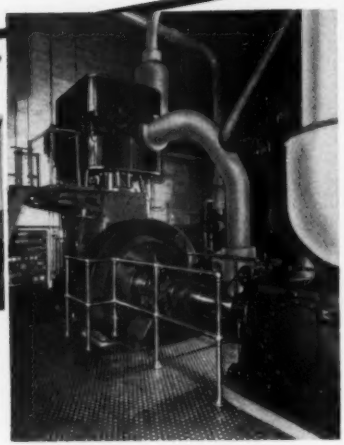


300-Kilowatt Horizontal "Universal Unaflow" in Meat Packing Plant.



Two-cylinder "Universal Unaflow" driving ammonia compressor, in Brewery Power Plant.

Hundreds of companies whose products are as diversified as milk, baked goods, candy, canned foods, meat products, and beer, have this in common . . . they require economical, unfailing power; they require steam for processing; they require steam for heat.

A SKINNER "Universal Unaflow" Engine installation gives them all three . . . abundant power produced by man's most economical prime mover . . . exhaust steam for utilization in processing . . . exhaust steam for space heating.

Food processing companies all over the United States and in many foreign countries have been depending on SKINNER "Universal Unaflow" Steam Engines for four decades . . . and as their operations are expanded, proved performance naturally leads to additional SKINNER Engine installations.

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operating conditions is small. Relation of load and speed is a relatively flat curve. So maximum speed reduction is small and resistance losses low. Stepup gears are always used whether or not motor has slip coupling.

Diesel or gas engines may be used for compressor drive with speed-increasing gears between engine and compressor. Speed and size of engine largely determine the engineering of this drive.

Controls. System capacity is balanced with load by, (1) varying compressor speed (2) regulating vapor flow from cooler by throttling damper and (3) reducing condenser water flow to increase compressor discharge pressure. Speed regulation is preferred capacity control.

Safety controls operate by opening an electrical contact that stops motor or reduces turbine speed to minimum when any of these conditions occur: (1) low oil pressure in compressor (2) high condensing pressure (3) low refrigerant evaporating temperature and (4) low chilled-water temperature. Safety controls protect against mishandling and accidental operating conditions. Besides these controls there are thermometers and pressure gages in various parts of the system. These permit operating checks of system performance.

Coming articles in this series deal with compressor operation, maintenance and repair. In these, important operating elements outlined here will be covered in greater detail, as well as refrigerant properties.

Hot Lime Zeolite

(*Continued from page* 113)

content in water. It requires, for apparatus, one set of matched low form 50-ml nessler tubes, two 1-ml graduates and one 5- and one 10-ml volumetric Exax pipettes.

For reagents, the method calls for magnesium-free distilled water to be used in all dilutions and in the preparation of standards. The magnesium standard itself is made up by dissolving 0.240 gr of magnesium (Mg) metal ribbon in hydrochloric acid, evaporated to dryness and diluted to 1 liter. Then 5 cc is taken from this flask and diluted to 1 liter in a second flask; 10 ml of this solution diluted to 50 cc in a nessler tube is equal to 1 ppm magnesium as $CaCO_3$.

The remaining reagents are Titan yellow A, 0.05% aqueous solution, hydroxylamine hydrochloride, 5% aqueous solution, sodium hydroxide, 1 normal solution.

This method works out very well with waters containing less than the

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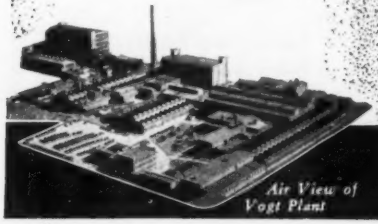

Air View of Vogt Plant

HENRY VOGT MACHINE CO., Inc.,
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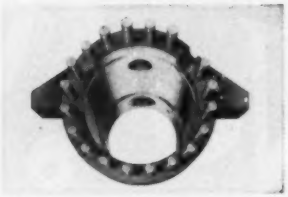
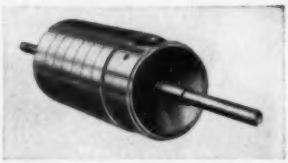
Here's how your high pressure Boiler Feed Pump is Precision Built by Pacific

1 The steel forging for the outer case is thoroughly annealed.

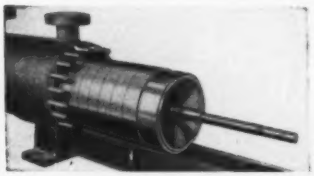


2 The outer case is precision finished.

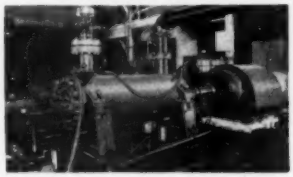
3 The diffusers and impellers are chrome alloy steel—impellers dynamically balanced.



4 The unitized internal assembly is assembled outside the case. All parts are precision finished.



5 The unitized internal assembly is installed in the outer case.



6 The pump is completely assembled—then performance tested.

7 Following test, pump is dismantled; checked; inspected; reassembled.

8 A precision-built, performance-tested, inspected Pacific Pump is on its way!

PACIFIC *Precision Built* PUMPS

Bulletin 109 Gives Details

Pacific Pumps inc.

ONE OF THE DRESSER INDUSTRIES

HUNTINGTON PARK, CALIFORNIA

BF-8 *Export Office:* Chanin Bldg., 122 E. 42nd St., New York ★ *Offices in All Principal Cities*

amounts listed of the following dissolved substances: 300 ppm total dissolved solids, 20 ppm calcium, 0.5 ppm iron, 3 ppm aluminum, 300 ppm ammonium, 100 ppm phosphate, any trace of magnesium, zinc or copper.

The actual procedure involves the following:

1. Measure out 50 ml of clear or filtered sample to be tested into nessler tubes. Prepare standards corresponding to 0.1, 0.2, 0.5, 1.0, 1.5, 2.0 2.5 and 3.0 ppm Mg as $CaCO_3$. If the water has a magnesium content above 3.0 ppm a dilution should be made. A blank on reagents should accompany each run.

2. Add 1 ml of hydroxylamine hydrochloride solution to each tube and mix.

3. Add 1 ml of the Titan yellow A to each tube. Make this addition with great care to insure same addition of dye to each tube. Then mix.

4. Wait 5 minutes before comparing samples against standards to obtain the magnesium content. Make the comparison under a white light against a white background for best results.

PLANT PROBLEMS

(*Continued from page* 134)

ate for balanced loads. For accurate tests employ testing firm. They'll do the job at reasonable cost.

GEORGE MCNALLY *Kearny, N.J.*

Consult Meter Test Firm

FROM A LEGAL and commercial standpoint it is best for *JB* to obtain services of a competent meter-test firm. This way he'll be certain of results and won't be wasting his time and energy on a delicate job that requires experience and know-how.

But if he wants to conduct his own tests without removing meters or interrupting service he can. There are no "fast means" that give correct values. Use indicating instruments and stop watch, or the rotating standard method. Latter is good for fluctuating loads.

Schedule periodic tests of whr meters to insure continued reliability. Time between tests depends on meter size or current-carrying capacity.

CARL BACHMANN *Forest Hills, N. Y.*

Tests Are Easily Made

TEST PANEL-MOUNTED whr meters in place, especially when they are difficult to remove. This is also true when removal might be hazardous. Test equipment is easily connected by test links into circuits of modern installations.

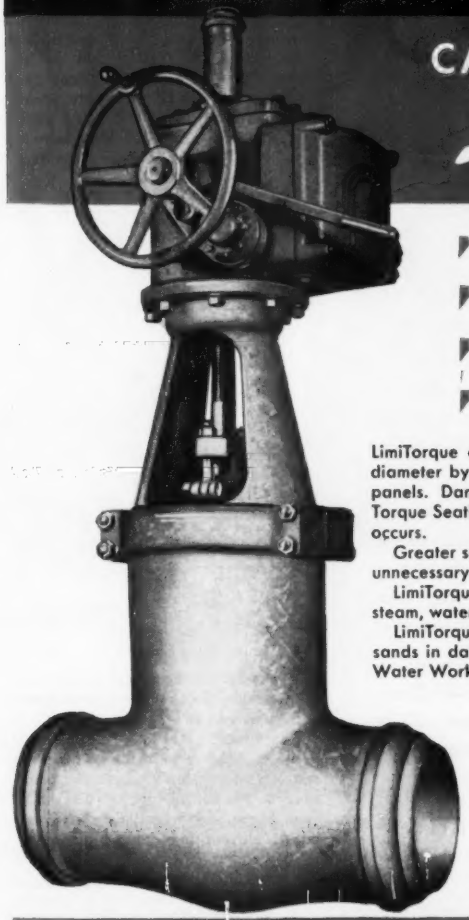
Secure ac and dc rotating standard 2-wire whr test meters of correct capac-

ANY TYPE OF VALVE

any place, any time, by any power-source available

CAN BE OPERATED BY

Limitorque



- ✓ INSTANTLY
- ✓ ACCURATELY
- ✓ SAFELY
- ✓ DEPENDABLY

LimiTorque opens and closes valves of all makes and types up to 96" diameter by the "push of a button" from either remote or nearby control panels. Damage to stem, seat, disc, gate or plug is prevented because the Torque Seating Switch *limits the torque*, shuts off the motor if an obstruction occurs.

Greater safety is afforded workmen by LimiTorque Remote Control as it is unnecessary to go to high, low or dangerous locations for manual operation.

LimiTorque may be actuated by any available power source . . . electricity, steam, water, gas, oil or air.

LimiTorque Controls are obtainable through valve manufacturers. Thousands in daily use on land and sea . . . in Power Plants, Central Stations, Water Works, Refineries, and Oil Pipe Lines.

For full details . . . write for Catalog L-50 — please use your Business Letterhead.

Philadelphia Gear Works, INC.

ERIE AVE. AND G ST., PHILADELPHIA 34, PA.

NEW YORK • PITTSBURGH • CHICAGO • HOUSTON

IN CANADA: WILLIAM AND J. G. GREEY LIMITED, TORONTO

Industrial Gears and Speed Reducers
LimiTorque Valve Controls

The DUO-STEP Leverage

It's startling news when a steam trap manufacturer suggests that you're using *too many* steam traps.

But if it takes *two* ordinary traps to do a job that can be done with *one* Clark Duo-Step, it's obviously a waste of money.

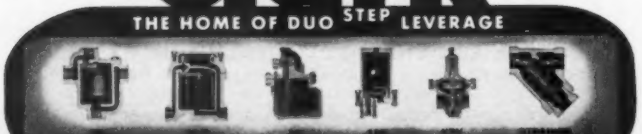
Clark Duo-Step Leverage actually gives *double the drainage capacity* of old-fashioned traps. This saves you money three ways: (1) in original trap cost, (2) installation and (3) maintenance.

Ask your Clark representative for an eye-opener demonstration of Duo-Step on your own steam lines . . . or write us for additional information.

Here's how DUO-STEP doubles drainage capacity

THE CLARK MANUFACTURING COMPANY
1831 East 38th St. • Cleveland 14, Ohio

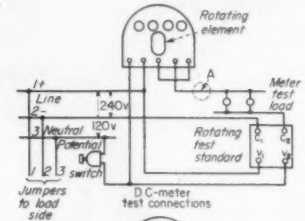
Clark
THE HOME OF DUO STEP LEVERAGE

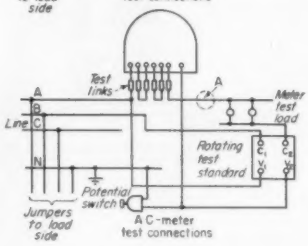


The complete line of dependable fluid controls

ity for units to be tested. Rent or purchase; unless much routine testing is being done, buying these instruments mightn't be advisable because they're expensive. Also obtain from meter manufacturer the test constants with instructions for their use and explanation for any specific requirements, including complete diagrams of internal meter connections.

With all test equipment and instructions on hand, install jumpers as in sketches. Meters can then be tested regardless of existing load. Complete disconnection is best because meter can be put through full range of load tests irrespective of actual load conditions in plant circuit. Test load may be any type of resistor or merely a lamp bank and an ammeter as a check to prevent overloading. Sets of meter test resistances with selective switching units are available. Connections shown indicate





only general arrangements; others may be desirable. Test clips for current and voltage should be on hand.

Check each meter to see elements revolve in same direction before making test. Remove nontransparent meter cases so you can see marked disk. With connections and potential switch open, adjust current load to desired value, after setting marked disk where each revolution is observable. Close potential circuit and allow meter under test to make 20 to 30 revolutions, stopping test by opening potential switch. Revolutions of recording standard are automatically recorded on dials. Since both service and test meters operate together, time period for each is the same, and stop watch isn't needed. Allow meters to warm up before testing.

At completion of each test, accuracy is found from: % accuracy $= (R_t K_t)\ 100/R_s K_s$, where $R_t =$ rev of service

IT ALWAYS PAYS TO SPECIFY

LADISH

Controlled Quality

PIPE FITTINGS

...you know they are in to stay

Long, trouble-free piping service results from extra safeguards in the manufacture of Ladish fittings. Rigid laboratory controls over chemical composition and physical properties of steel provide an assurance of maximum strength and resistance to erosion or corrosion. These are some of the extra safeguards for dependable operation which you always get in greatest measure in Ladish Controlled Quality Fittings.

THE COMPLETE *Controlled Quality* FITTINGS LINE
PRODUCED UNDER ONE ROOF...ONE RESPONSIBILITY

LADISH CO.

CUDAHY, WISCONSIN
MILWAUKEE SUBURB

District Offices: New York • Buffalo • Pittsburgh • Philadelphia • Cleveland • Chicago • St. Paul
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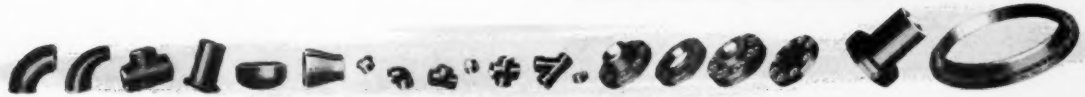
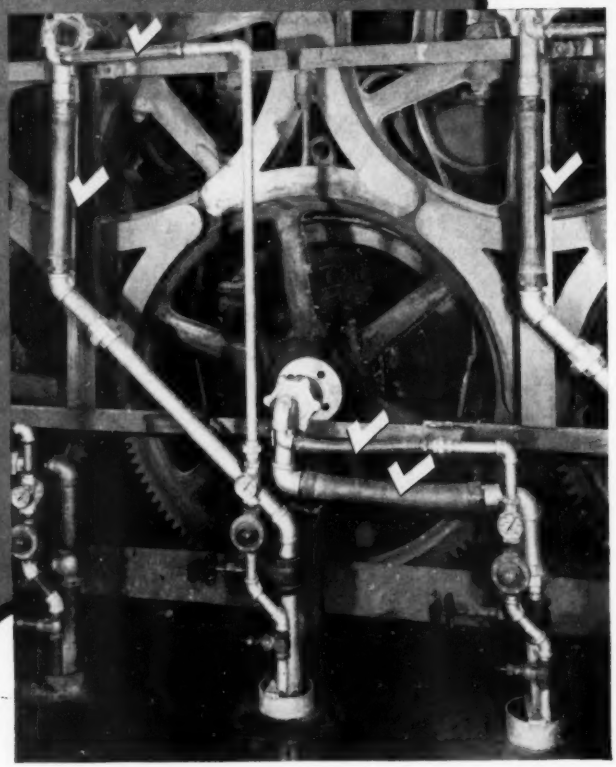


CMH FLEXIBLE METAL HOSE

cuts maintenance ...helps keep dryer temperatures constant on this paper machine



By replacing rigid pipe connections to the dryer cylinders of this paper machine with sections of CMH Flexible Metal Hose it was possible to reduce maintenance and minimize paper spoilage due to improper drying. In the rigid pipe hook-up, vibration in the machine caused early failure of the packing in the rotary joints. Steam loss through the damaged packing and its attendant temperature drop resulted in insufficient drying, necessitating the discarding of this paper. CMH REX-WELD corrugated, braid-covered, bronze hose installed as steam inlet and condensate return connections to the rotary joints absorb the vibration and end this damage to packing. In addition, the flexible metal hose corrects for misalignment, takes any normal motion in the system and absorbs thermal expansion and contraction.

With production demands at their present level, don't risk spoilage of your product or complete shut-down resulting from faulty connections. Check your connections now. All those subject to vibration, misalignment, flexation or expansion and contraction should be replaced with CMH Flexible Metal Hose. There's a size and type to meet every need. For full details call your CMH distributor. Look for him in the classified telephone directory or write for his name.

See Our Catalog in Sweets' File

Flexon identifies CMH products that have served industry for over 49 years.

CHICAGO METAL HOSE Corporation

1301 S. Third Ave. • Maywood, Ill. • Plants at Maywood, Elgin, Rock Falls, and Savanna, Ill.
In Canada: Canadian Metal Hose Co., Ltd., Brampton, Ont.

CMH

ONE DEPENDABLE SOURCE
for every flexible metal hose requirement

Convoluted and Corrugated Flexible Metal Hose in a Variety of Metals • Expansion Joints for Piping Systems
Stainless Steel and Brass Bellows • Flexible Metal Conduit and Armor • Assemblies of These Components

Bring on the overloads...

With its Sequence Head control, Hydrovac is practically automatic, and Hydrojet involves no labor beyond the occasional turning on and off of valves.

we'll handle the ashes and dust!

No matter how much coal you stoke to meet rising demands, Hydrojet and Hydrovac will assure you of swift, efficient refuse disposal.

You can adequately step up the cycles of operation—and yet require only the part-time duty of one or two men. If these men are needed elsewhere, novices can quickly learn to operate these systems. Since few moving parts come into contact with ashes or dust, and the ashes float high without scraping the sluices, replacement interruptions are reduced to a minimum.

Each plant has its own problems. The pioneers in modern ash and dust handling will help you devise your most satisfactory solutions. Write us today.

THE ALLEN-SHERMAN-HOFF CO.
227 South 15th Street, Philadelphia 2, Pa.
Offices and Representatives in Principal Cities

HYDROJET for ASH handling — HYDROVAC for DUST handling

Pritchard's *New*

Type "E" Quintair*

AIR COOLED HEAT EXCHANGER

For Low Cost, Efficient Cooling or Condensing of Liquids, Gases or Vapors

- Lower Operating Costs
- Higher Efficiency
- Fewer Parts to Assemble
- Lower Maintenance Costs
- Lower Installed Cost
- Many Industrial Uses

Other types of Quintair* units also available to meet your requirements.

Write for FREE Bulletin No. 11.0.080

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CHICAGO • HOUSTON • NEW YORK • PITTSBURGH • TULSA • ST. LOUIS
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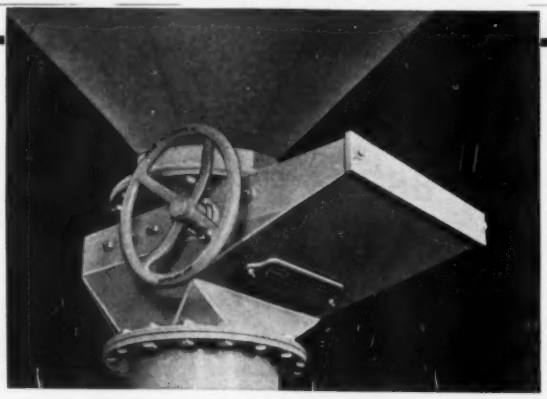


S-E-CO. COAL VALVES are equipped with U-shaped gates. This construction assures easy operation of the valves because operating racks, pinions, and supporting rollers are in a space at the side, and, therefore, moisture in the coal does not run over these parts and cause rapid corrosion and subsequent sticking of the valve.

Write for bulletin.

STOCK EQUIPMENT COMPANY
715P Hanna Building ★ Cleveland 15, Ohio

meter, K_t = service meter watthour constant, R_s = rev of rotating standard meter, K_s = rotating standard watthour constant. Use test-meter accuracy curve for further correction. When service and standard meters have same test constant, accuracy is found by comparing revolutions and above equation becomes: % accuracy = 100 R_t/R_s. Test requires little time.

Test ac meters at different power factors, if needed, say 100 and 50%. At 50% pf, test by cross-connecting potential coils. For other values a phase shifter may be used.

C O VON DANNENBERG *Brooklyn, N.Y.*

Three Alternatives

BEST METHOD of checking any meter is to compare it with one known to be accurate. Connect another meter into circuit without removing switchboard meter. But it usually pays to place meter in shop for a complete cleaning and calibration. This holds especially true for *JB* whose meters haven't been checked since installation. He has three possible alternatives:

1. Purchase portable whr meter for ac and dc circuits and attach in circuit to be tested. Defective switchboard meter can be spotted immediately by comparison. But whr meters are a fairly heavy investment and are useless except for this test.

2. Purchase portable recording wattmeter. This is also a heavy investment but instrument is useful tool in any plant and isn't limited to checking other meters. Watthours must be computed from wattmeter chart, involving some calculation.

3. Remove meters, one at a time from switchboard. Return to manufacturer or local utility for checking. Connect substitute meter in line or estimate bill for period from previous experience.

Best method depends on local conditions. Utilities are usually cooperative in solving these problems and may be willing to lend or rent replacement meters while *JB's* are in shop.

D H NOBLE *Wilmington, N.C.*

Test Procedure Outlined

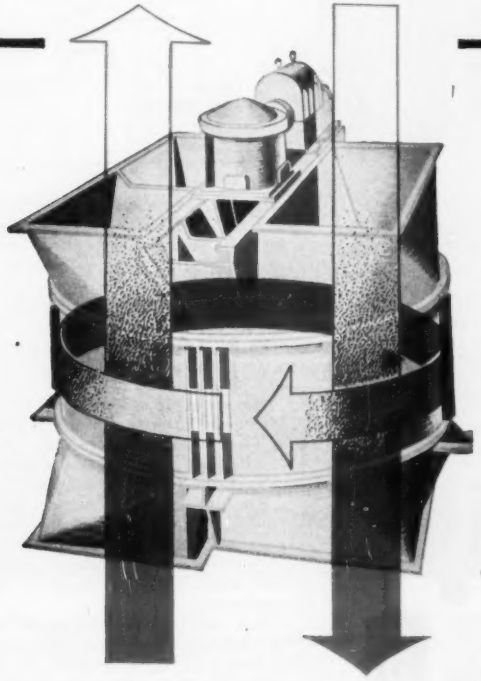
DC METERS are subject to fewest errors. Check on the job if an accurate voltmeter, ammeter and a constant load are available, or if you have accurate dc whr meter. Or use two dc wattmeters with a constant load. Checks can't be made without one of these sets of equipment.

Since energy in dc circuit is product of volts, amperes and time, meter can be checked if there's a constant load with constant voltage. Use two ammeters

more than 200,000,000 lbs/hr of post-war steam generating capacity

equipped with *Ljungstrom*

AIR PREHEATERS



Here indeed is impressive evidence of the wide acceptance of the Ljungstrom air preheater. Since the war the total capacity of steam generating units equipped with Ljungstrom air preheaters, installed, under construction or on order in industrial and utility plants throughout the country comes to well over 200,000,000 lbs of steam per hr.

The reasons for the steadily increasing preference for the Ljungstrom air preheater are simple enough. The continuous regenerative counterflow principle assures maximum heat transfer with minimum weight and size. Flexible and compact, it may be used in a wide range of applications. Its proven reliability and low maintenance eliminate costly shutdowns.

If you are planning to build a new plant or modernize an old one, investigate the possibilities of the Ljungstrom. The specialized experience of Air Preheater engineers is at your disposal, to aid in effecting the most economic heat recovery from flue gases.

The Ljungstrom operates on the continuous regenerative counterflow principle. The heat transfer surfaces in the rotor act as heat accumulators. As the rotor revolves the heat is transferred from the waste gases to the incoming cold air.

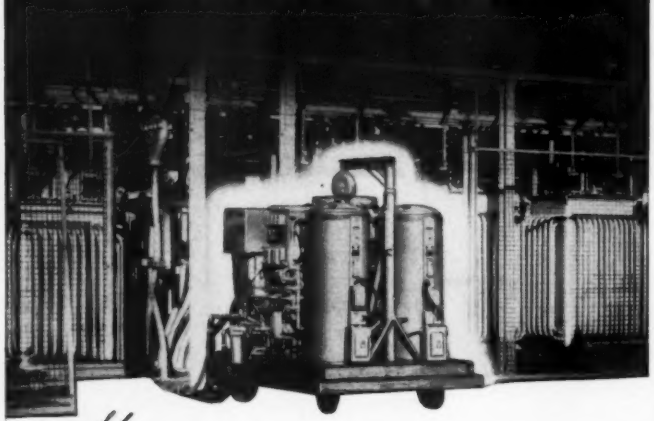
THE AIR PREHEATER CORPORATION

60 EAST 42d STREET • NEW YORK 17, NEW YORK

Eliminate SHUT-DOWNS and EXPENSIVE REPAIRS

on Transformers, Turbines and Diesel Engines

with HONAN-CRANE Oil Purification Equipment



Many leading utilities such as Detroit Edison, Ohio Public Service Co., Pennsylvania Power, etc., have standardized on Honan-Crane oil purification equipment for removal of damaging contamination from insulating, Turbine and Diesel oils.

Honan-Crane can give you exact equipment to do the job. Equipment that will remove all types of oil contamination.

In every installation Honan-Crane equipment quickly pays for itself out of savings in oil and maintenance costs.

● Write today for Honan-Crane Bulletins: "Purification of Insulating Oils", "Purification of Turbine Oils".

FOR TRANSFORMER INSULATING OILS

Houdaille Purivac (Shown Above)

A complete automatic system for purifying, dehydrating and degasifying insulating oil in the field or at a central location. For large volume purification requirements.

Honan-Crane "R" Type Purifier

Mobile oil reconditioning unit for centralized batch purification. Ideal for volumes of oil requiring capacities up to 200 GPM.

FOR TURBINE AND DIESEL OILS

Honan-Crane "M" Type Purifier (Right)

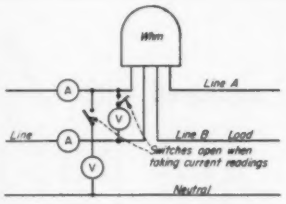
"Continuous" type purifier removes solid contamination as well as products of oxidation (acids, asphaltenes, gums and resins). Keeps neut. number and steam emulsion number within desired limits. Sizes to fit all needs.

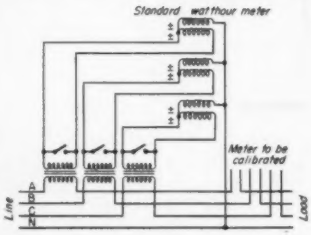
CLEAN OIL ENGINEERING

HONAN-CRANE CORPORATION
1200 SIXTH ST., LEBANON, INDIANA
a subsidiary of
HOUDAILLE-HERSHEY CORPORATION

in series with load and two voltmeters across it. With 120/240 v system, check meter with unbalanced loads for complete job.

When true whr meter is available, check by comparison, constant load or not. Standard portable units are available for this job. Meter needn't be taken off panel for any of these tests. Upper sketch shows voltmeter-ammeter method. Connections for either wattmeter or





whr meter are same as for JB's present meter. Should meter be in error, correct by moving drag magnet radially on old meters or by adjusting magnetic shunt on newer ones.

Ac whr meters are troublesome to check; subject to many errors, corrections for these are interdependent. Use three wattmeters or three single-phase whr meters.

Better method uses standard 3-phase whr meter in series with meter tested. If his ac load is greater then 1 kw, standard whr meter will probably need one current transformer for each current coil, lower sketch. Short-circuit the current transformer secondary when not connected to whr-meter current coil. This prevents high secondary voltage that might injure personnel or ruin transformer.

Run tests from no load to full load in several steps and power factors from at least 0.70 lagging to 1.00, and unbalanced loads to greatest degree of unbalance existing in normal operation. Find unbalance with voltage measurements from line to neutral for each of three lines.

Best bet for *JB* is to send his meters to local utility where they are set up for these tests. Charge is nominal and utility may furnish substitute meters while his are being calibrated.

W M Montgomery *Des Plaines, Ill.*

Car goes up 120 times a day —but costs stay down

THE car on the Duquesne Incline, Pittsburgh, Pa., shown below makes 120 round trips every day. The operator-engineer reports that the Westinghouse Speed reducer used to drive the hoist "has been in use 18 years and has given no trouble whatsoever".

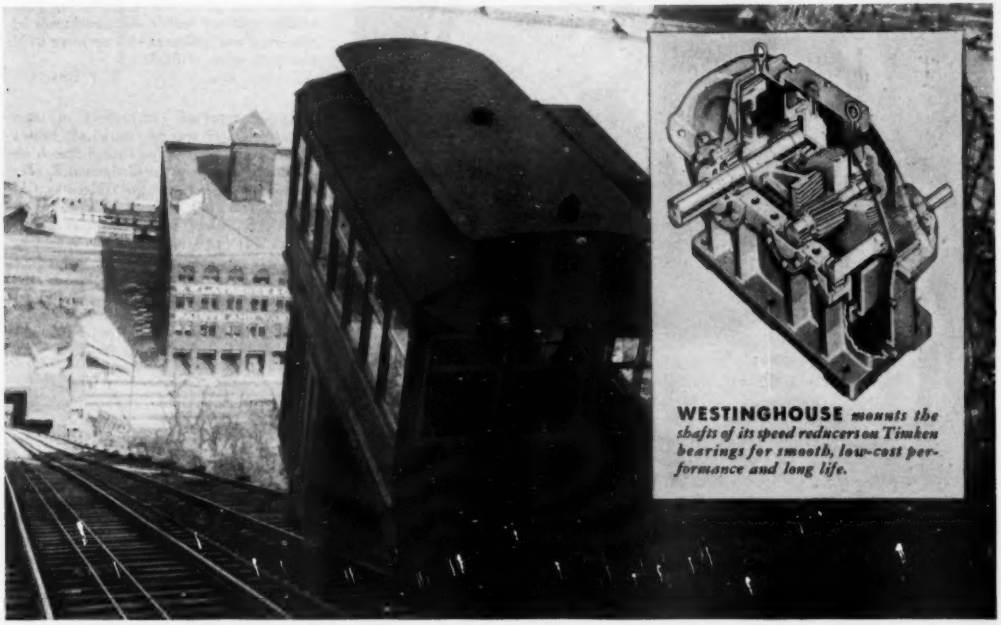
One important reason for the trouble-free, low-cost service of this drive unit is the gear shaft mounting. All shafts are mounted on Timken® tapered roller bearings.

Timken bearings keep the shafts in rigid alignment, the gears meshing smoothly. Wear on moving parts is reduced. The tighter closures made possible by Timken bearings retain lubricant better, keep dirt out.

The tapered design of Timken bearings enables them to carry all the radial, thrust and combination loads. The tremendous load capacity needed for the job is provided by line contact between rollers and races. Friction is minimized by the true rolling motion and extremely smooth surface finish of the bearings. And Timken bearings are engineered and manufactured to last for the life of the unit.

Make sure the equipment you build or use has all the advantages that Timken bearings alone can give it. Look for the trade-mark "Timken" on the bearing. The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".

This symbol on a product means its bearings are the best.



WESTINGHOUSE *mounts the shafts of its speed reducers on Timken bearings for smooth, low-cost performance and long life.*

DESIGN LEADERSHIP

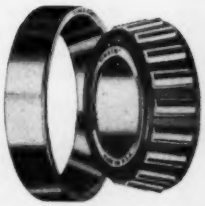
The first Timken tapered roller bearing was produced in 1898. Since then the one-piece multiple perforated cage, wide area contact between roll ends and ribs, and every other important tapered roller bearing improvement have been introduced by The Timken Roller Bearing Company.

The Timken Company leads in: 1. advanced design; 2. precision manufacture; 3. rigid quality control; 4. special analysis steels.

TIMKEN

TRADE-MARK REG. U. S. PAT. OFF.

TAPERED ROLLER BEARINGS



NOT JUST A BALL ○ NOT JUST A ROLLER ⬭ THE TIMKEN TAPERED ROLLER ⬭ BEARING TAKES RADIAL ◎ AND THRUST →◎← LOADS OR ANY COMBINATION ✳

R·P&C
VALVES

NO. 6056
Forged
Steel
Gate Valve

Here is a Premium Valve that is NOT premium priced

CHECK THESE DESIRABLE FEATURES:

- Bolted bonnet construction
- Heat-treated and hard chrome plated stainless steel wedge
- Stainless steel gland eye-bolts and nuts
- Two-piece gland and follower
- Tongue and groove bonnet joint

It's well designed. It's low priced in its field.
See your R-P & C distributor or write nearest R-P & C district office.

ACCO
Atlanta, Chicago, Dallas, Detroit, Houston, New York, Philadelphia, Pittsburgh, San Francisco, Bridgeport, Conn.

R-P & C VALVE DIVISION
AMERICAN CHAIN & CABLE

"Intentionally Better"
READING-PRATT & CADY VALVES

With Our Readers

(Continued from page 5)

clusively for the generation of power, it is far from true that it is the first power-producing gas turbine.

Brown Boveri Co designed and built, as you undoubtedly know, a comparatively large number of gas turbines for the Houdry process, all of which, however, generate power as a byproduct. Some of these turbines have been running now for 15 years with little or no trouble of any kind . . . Yet we find that the great majority of your readers with whom we have been in contact believe that this Oklahoma Gas and Electric Co turbine is the first successful gas turbine in the United States.

In your January contents page you make the statement "All eyes still focus on America's first commercial power-producing gas turbine." Whereas we realize that due to the insertion of the word "commercial" this statement is perfectly true, we still feel that if some further explanation is not given the majority of your readers will not realize the significance of this word and will read this sentence as if the word were omitted. . .

Tucson, Ariz. E J HUSTED

Having reported (exclusively in most cases) the pioneering work of Brown Boveri in Europe and the United States, we are keenly aware of the distinction Reader Husted makes between the Oklahoma Gas and Electric Unit (first to be installed in the U. S. solely for commercial power generation) and the Houdry machines (first gas turbines in the U. S. to produce power). Best testimony to this is the care we have exercised in properly describing the OG&E unit. If further clarification is needed we're sure Reader Husted's letter and this note supply it.—*Ed.*

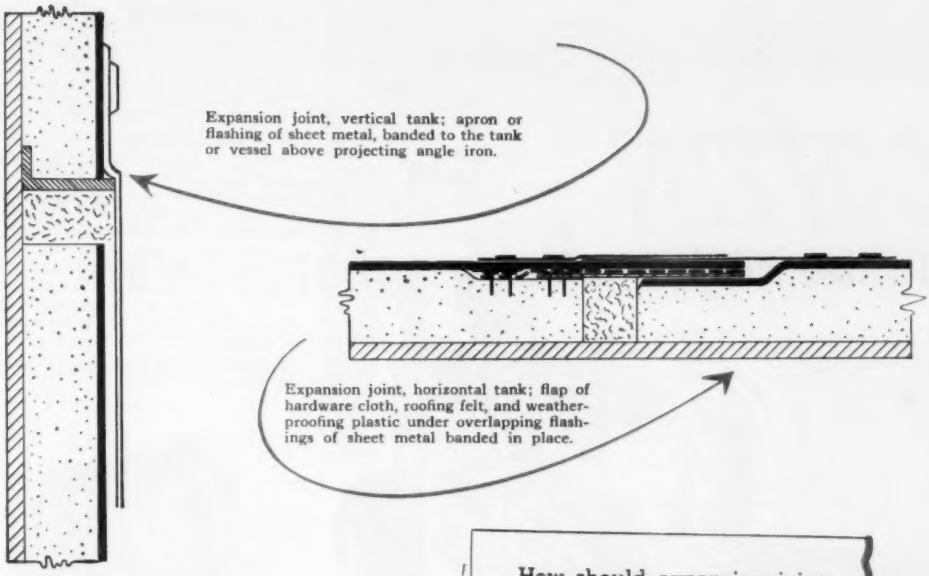
BOOKLET

PASSENGER ELEVATORS BUYER'S GUIDE. *52 pages, 8½x11 in., 46 illustrations, stiff paper cover, available on request written on company letterhead. Westinghouse Electric Corp, Elevator Division, Jersey City, N.J.*

This publication has been written as a guide for those interested in transportation of passengers in office buildings, hotels, stores, apartment houses, hospitals, banks and industrial plants.

It deals with the component parts of elevators, types of elevator control, how to select passenger elevators, price data, layouts, installations, modernization and protective maintenance.

Much of this information will assist architects, consulting engineers, and building managers in preparing plans for passenger elevators.


Expansion joint, vertical tank; apron or flashing of sheet metal, banded to the tank or vessel above projecting angle iron.
Expansion joint, horizontal tank; flap of hardware cloth, roofing felt, and weatherproofing plastic under overlapping flashings of sheet metal banded in place.

WE HAVE BEEN ASKED:

How should expansion joints in tank insulation be weatherproofed?

Recently an engineer in a large chemical company wrote, "We would like to know what method you would recommend for weatherproofing the expansion joints in the insulation on tanks and vessels."

While there are several methods of weatherproofing expansion joints we have found that two of them are usually the most practical for general application. One method is used for vertical tanks and vessels and the other is employed on horizontal equipment.

On horizontal tanks we suggest that a flap of roofing felt, hardware cloth, and weatherproofing plastic be overlapped at the expansion joint, and in addition overlapped flashings of sheet metal should be applied. This construction effectively seals out moisture and allows for movement of the tank or vessel without damage to the insulation.

For an expansion joint in a vertical tank we recommend an apron or flashing of sheet metal banded to the tank or vessel above the projecting angle iron. This method is moderate in cost and provides positive assurance that the joint can open and close freely without damaging the insulation. Maintenance is simple and inexpensive.

Proper design of a weatherproof expansion joint is just one of the many small details of an insulation job. But these small details are important. The way they are handled can mean the difference between good and poor insulation performance. Armstrong engineers, construction foremen, and insulation mechanics know the importance of these details. They take pride in their ability to handle them correctly. The next time you plan an insulation job of any kind, why not take advantage of this skill and knowledge.

SEND US YOUR QUESTIONS: If you have any questions on the use or application of either high- or low-temperature insulation, please do not hesitate to write to us. We'll do our best to give you a practical answer. Just address a letter or post card to Armstrong Cork Co., 7003 Maple Ave., Lancaster, Pa.

ARMSTRONG'S INDUSTRIAL INSULATIONS

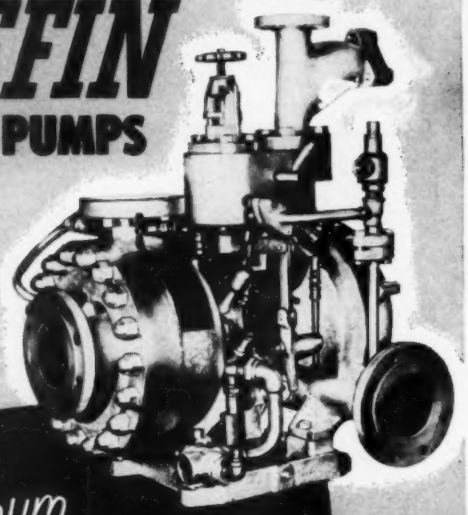
MATERIALS - INSTALLATION

FOR ALL TEMPERATURES FROM 300°F. BELOW ZERO TO 2800°F.

Specify high speed, single stage

COFFIN TURBO PUMPS

MATCHED PUMP, TURBINE AND GOVERNORS IN ONE COMPACT LIGHTWEIGHT ASSEMBLY



–for minimum steam consumption

The Coffin high efficiency pump combined with a high speed two bucket row turbine result in minimum steam consumption on even the toughest pumping operations. For example, Coffin single stage pumps at 7200 RPM are the approximate equivalent of 3 to 6 stage pumps at 3600 RPM. Coffin 12 inch turbine bucket wheels at 7200 RPM are equal to 24 inch turbine bucket wheels at 3600 RPM. Superb Coffin engineering includes many other maintenance-saving features. Get all the facts on Coffin designed Turbo Pumps, now!

STANDARDIZED PARTS REDUCE LOSS OF TIME

All Coffin models are assembled to specification from standardized stock parts. Fast service from regular stocks of any wearing part is available at all times. For immediate shipment of guaranteed rebuilts, check on the time-saving Coffin Exchange Plan!

Ask for free DATA FOLDER

Contains complete specifications and operational data on Coffin Turbo Pumps for marine and general service. Call or write today, for your copy.

COFFIN

THE J.S.COFFIN, Jr. COMPANY

824 SOUTH DEAN STREET
ENGLEWOOD, NEW JERSEY

REPRESENTATIVES IN ALL PRINCIPAL CITIES

EQUIPMENT NEWS

(*Continued from page* 152)

For more data on these items, use post cards, p.194a. Identify request with P and number.

STEAM-JET CLEANING **P314**

Plants that have high-pressure steam, but would like to take advantage of the *Speedy-lectric* system of steam jet-cleaning, can now get the new Model 100. It includes a high-pressure detergent tank mounted on a lightweight all-metal dolly with 10-in. rubber-tired wheels. It also comes with 25 ft of high-pressure steam hose and 25 ft each of outlet steam and detergent hose for connection from the tank to the *Speedy-lectric* steam lance.

Livingstone Enginering Co, 100 Grove St, Worcester 5, Mass.

PACKAGED AIR CONDITIONER **P305**

Automatic water-regulating valve, built-in thermostat and limit control, bonderized cabinet of 16-gage steel are features of new 11-ton packaged air conditioner occupying 11.25 sq ft of floor space. Unit has a sealed radial compressor operating at 3500 rpm, a cooling capacity of 132,000 Btu, two dynamically-balanced fans, both suspended in self-aligning cushioned bearings. The large return-air grille is equipped with cleanable-type filters.

Air-Temp Div, Chrysler Corp, Dayton, Ohio.

CLUTCH BRAKE **P338**

Air-powered combination friction clutch and brake unit drives medium and heavy machinery. Brake shoe and lining assemblies can be easily changed. Clutch disk scoring stopped because rivet heads cannot come in contact with disks. Disks are bolted in place and actuating mechanism is so designed that linings are pulled from contact with the disks.

Brake and clutch cannot be engaged at same time. Unit controlled by a solenoid valve to admit compressed air to the clutch to engage it and release the brake. If electric current or air fails, valve closes.

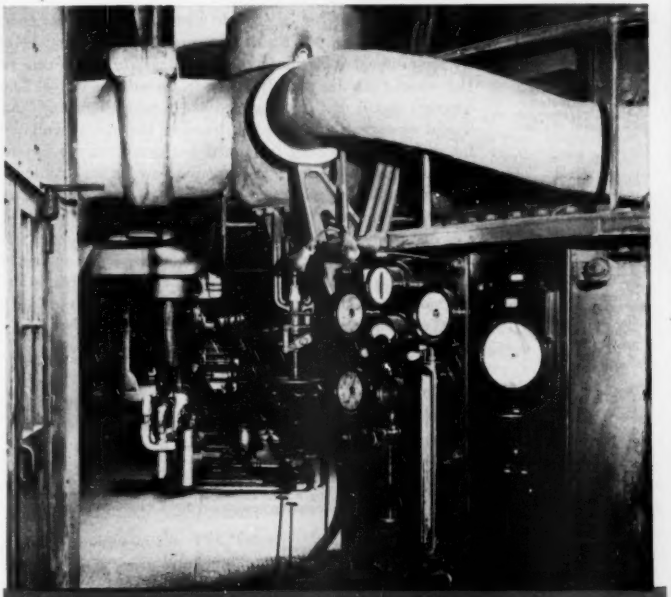
TRADE PAPER EDITION
Published by
SCHUTTE and KOERTING Company

ENGINEERING News

JET APPARATUS • HEAT TRANSFER EQUIPMENT • SYPHONEERS • CONDENSERS AND VACUUM PUMPS • OIL BURNING EQUIPMENT • ROTAMETERS • FLOW STABILIZERS • REGULATORS • VALVES • SPRAY NOZZLES • HOT WATER HEATERS

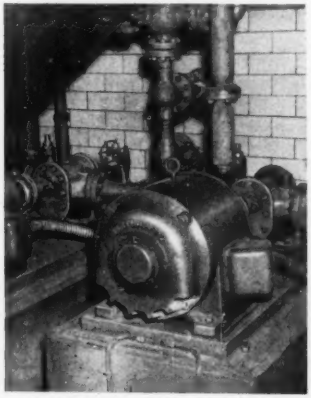
SK HIGH PRESSURE VALVES FACE LIFE AT 40

FOR almost 40 years, three SK Inverted Turbine Throttle Valves have been performing efficiently with minimum maintenance at the Schuylkill Station of the Philadelphia Electric Company. They are still going strong. When the valves were installed, force for tripping was based on a differential area closing piston. Today, SK Valves of modern design are provided with springs for tripping. The particular valve shown in the close-up, one of the three, has a 14" inlet and two 10" outlets. It is located on the steam header to a 14,000 kw Turbine and passes 325,000 lbs. per hour of steam at 220 psi. Each of the three valves serves one turbine. This long-life installation is typical of SK equipment. Over the years, we have accumulated a file of testimonials from SK customers satisfied with the efficiency and durability of SK Valves. We feel this justifies the SK policy that equipment, designed and built, not to meet a price, but to perform efficiently over a long period of time is the most economical in the long run. There are SK Valves to meet *your* needs. *Write for Bulletin* 8-D.



Efficiency and Economy Keynotes of SK Gear Pumps

Rugged pumping problems dictate soundly engineered pumps constructed of durable materials to insure long life and minimum



maintenance. SK Gear Pumps are just that! Take for example this New England power plant installation. The two pump sets pictured are each required to handle 40 gpm of No. 6 fuel oil at 860 rpm against 230 psi. Since the day they were installed, these pumps have built up an impressive continuing record for efficient and economical operation.

Built in any practical material, SK Gear Pumps will handle liquid free from solids in capacities up to 1000 gpm, and pressure to 3500 psi.

Schutte and Koerting Company maintain high standards of quality in all Gear Pumps by the strictest supervision of each step in the manufacturing process.

Whatever your pumping requirements, investigate SK Gear Pumps which are available from stock. Write for Bulletin 17-*A.*

SK ROTAMETER BULLETIN

SK Bulletin 18-RA lists the various types and applications of SK Rotameters. *Request your copy.*

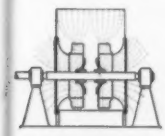
SCHUTTE and KOERTING Company
Manufacturing Engineers
[illegible] CORNWELLS HEIGHTS, BUCKS COUNTY, PA.

(*Advertisement*)

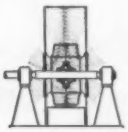
ANOTHER pd DEVELOPMENT

Gives you GREATER CONVERSION

OF VELOCITY PRESSURE TO STATIC PRESSURE



How P-D split wheel assists diffusion—aids distribution throughout the fan.

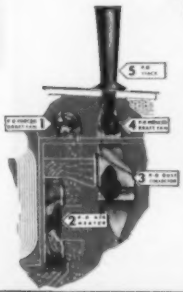


Conventional double wheel with common disc produces concentration, results in poor diffusion.

Performance ratings of the Prat-Daniel F-D Fan are established according to the Standard Test Codes adopted by N.A.F.M. and the A.S.H.V.E.

Design characteristics provide unusually high conversion of Velocity Pressure to Static Pressure. This is accomplished by streamlined inlet cones that are larger in proportion to the wheel than are usually found in forced draft fans. The unusual depth of the cones provide a wider housing than would customarily be used, increasing the space available for diffusion. Precisely fashioned backward curved blades provide a nearly perfect aerodynamic flow across both leading and trailing edges. Double wheel fans are spaced apart to permit four way diffusion of air, further contributing to this conversion. Peak efficiency and horsepower curves fall well within normal fan selection range, offering the optimum in maximum efficiency and non-overloading characteristics.

These are all carefully researched features that have made the Prat-Daniel F-D Fan a highly efficient apparatus. Check these features before you decide on your next fan. Write for catalog No. 300 today.



UNIT RESPONSIBILITY

The Thermix Corp., project engineers for the Prat-Daniel Corp., offer all components required for the handling of air and gas: (1) P-D Forced Draft Fans; (2) P-D Air Pre-Heaters; (3) P-D Tubular Dust Collectors; (4) P-D Induced Draft Fans; and (5) P-D Fan Stacks. This unit responsibility, by a well known firm, relieves the engineer of the necessity of integrating equipment from various sources into the over-all project.

Sales and Project Engineers

THE THERMIX CORPORATION

GREENWICH, CONN.

Canadian Affiliates: T. C. CHOWN, LTD.
1440 St. Catherine St. W., Montreal 25, Quebec
50 Abell St., Toronto 3, Ontario

Designers and Manufacturers

PRAT-DANIEL CORPORATION

NORWALK, CONN.

This releases the air from the clutch causing the brake springs to release the clutch and apply the brake. Available also in single clutch and single brake units.
Power Presses, Inc, 615 Penton Bldg, Cleveland 13, Ohio.

For more data on these items, use post cards, p.194a. Identify request with P and number.

ELECTRIC CABLE HOIST P336

These heavy-duty hoists, built in ½- to 5-ton capacities, have motor enclosed in the cable drum to reduce weight and dimensions. Motor being enclosed in drum is protected against moisture, splashing liquids, weather, dust and corrosive atmospheres. Load hook oscillates on ball bearings and swivels on roller bearings and is suspended on a 5/16-in. plow-steel cable. Hoist operates on 220-, 440 or 550-v, 3-phase 60-cycle power with either pendant-rope or push-button control, the latter on a pendant cable.
Cleveland Chain & Mfg Co, Broadway & Henry St, Cleveland 5, Ohio.

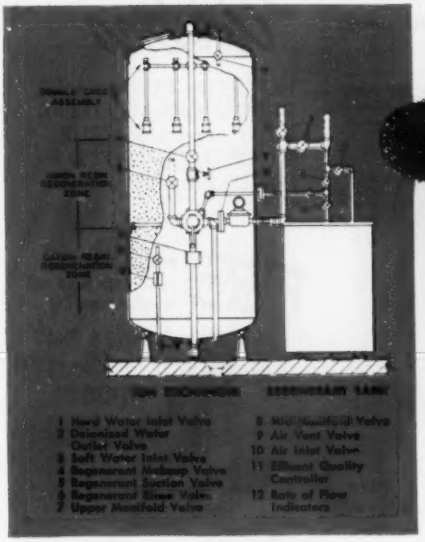
AUTOMATIC CLUTCH P334

Centrifugal clutch coupling constructed so it can be lifted vertically from its mountings on driving and driven elements without disturbing them. The driving spider slides back over the driving hub far enough to clear the driven half of the coupling, to permit either member to be lifted clear of the other. Couplings are available for either standard shoes or spring-controlled shoes in 6x2-in. to 24x8-in. sizes.
Centric Clutch Co, 22-26 South Ave, West Cranford, N. J.

PORTABLE AIR COMPRESSOR P329

Two-stage air-cooled compressor has 30-cfm capacity and maximum operating pres-

Highest Quality Mineral-Free Water At FRACTION of Evaporated Water Cost


1 Hard Water Inlet Valve
2 Deionized Water Outlet Valve
3 Soft Water Inlet Valve
4 Regenerant Makeup Valve
5 Regenerant Suction Valve
6 Regenerant Rinse Valve
7 Upper Manifold Valve
8 Lower Manifold Valve
9 Air Vent Valve
10 Air Inlet Valve
11 Effluent Quality Controller
12 Rate of Flow Indicators

SILICA REMOVED COMPLETELY

ELGIN Ultra DEIONIZER

(MonoFlo Design)

Only 18c* per 1000 gallons compared with $5.00 per 1000 gallons for evaporated water

*Based on 10 grain water

SOME OF OUR OTHER PRODUCTS

- Zeolite Water Softeners
- Dealkalizers
- Silica Removers
- Degasitors
- Water Filters
- Corrosion Control
- Feedwater Treatment
- Chemical Feed Systems
- Iron Removal Equipment
- Water Treating Chemicals
- Water Testing Equipment

Write for Bulletins

Here is a truly revolutionary development—a single tank "monobed" deionizer that brings the cost of high quality demineralized water within the range of those who have heretofore found evaporated or distilled water prohibitive in cost. Here is the perfect boiler feedwater that assures freedom from scale, silica, CO_2 corrosion, carry-over and costly blowdown. Yet the overall cost is comparable with ordinary water conditioning systems.

The single column Elgin DeIonizer produces water of higher quality than delivered by two and four-column demineralizers. In fact, for nearly all purposes, the water is freer from impurities than *distilled* water — and at a fraction of the cost. Naturally the compact Elgin Ultra DeIonizer costs far less to buy and operate. It requires but little space — is simple in operation — cuts regeneration time and rinse water requirements — and has other notable Elgin features which make it today's outstanding deionizing equipment.

Similar in design, but utilizing different ion-exchange resins, the Elgin MonoFlo DeIonizer is used where complete silica and CO_2 removal are not required.

These DeIonizers incorporate the famous Elgin "Double Check" manifold assembly which permits the use of a deeper bed of ion-exchange resins without loss — giving a marked increase in demineralized water output.

Write today for detailed information

ELGIN SOFTENER CORPORATION

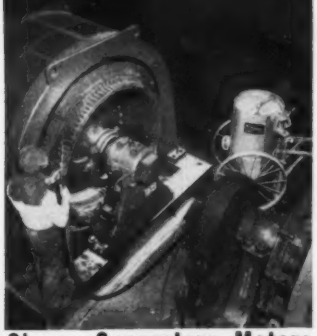
130 North Grove Avenue, Elgin, Illinois

ELGIN ECONOMICAL WATER CONDITIONING SINCE 1908

Water Conditioning Since 1908

PANGBORN AC-4

"CORN COB" Blast Machine



Cleans Generators, Motors

Faster Better Cheaper

Eliminates Toxic Hazard of Solvents!

THE new portable Pangborn AC-4 Blast Machine scours armatures, parts, frames, coils, etc. in ⅓ the time of other methods. Material costs are reduced 90% and toxic or explosive solvents are eliminated.

Look at the savings shown by this recent test on electric motors. (Name of Company on request.)

Cleaning Duplicate 500 hp Synchronous Motors		
	Material	Labor
Solvent Method	$55.00	120 hrs.
PANGBORN Method	5.00	40 hrs.
SAVING	50.00 (90.9%)	80 hrs. (66.7%)

Remarks: With Solvent, drying period took an additional 8 hours.

SIMPLE OPERATION

New Pangborn AC-4 Blast Machines use standard 40-pound air supply to remove oil and greases with blast of soft, 20-mesh corncob grits. No residue left on parts . . . no drying period.

FOR FULL INFORMATION, write today outlining your operation. Address: PANGBORN CORPORATION, 90 Pangborn Blvd., Hagerstown, Maryland.

Look to Pangborn for the Latest Developments in Blast Cleaning and Dust Control Equipment

Pangborn

BLAST CLEANS CHEAPER with the right equipment for every job

sure of 150 psi. Available either in trailer model or hand-truck model. Equipped with ASME air receiver, oil-bath air cleaners, protective V-belt guard. Features include: circumferential cooling fins; tube and fin-type air-cooled intercooler; positive by-pass unloader that holds inlet valve open during idling; feather valve, cast-iron honed cylinders, full-floating wrist pins, and others.

Worthington Pump and Machinery Corp, Harrison, N. J.

For more data on these items, use post cards, p.194a. Identify request with P and number.

UNIT SUBSTATION **P319**

A "midget" load-center unit substation designed for low-voltage lighting and power loads in industrial plants. *Inductrol Power Pack* incorporates an air circuit breaker, a dry-type transformer and an air-cooled induction regulator in one steel housing.

Unit is available in either single- or 3-phase ratings having a capacity from 15- to 100-kva. Incoming service voltage can be either 480 or 600 volts, 60 cycles and regulated output at 120/240 or 120/208 volts.

With these regulating units power can be brought to the load area at relatively high voltage with substantial savings in cable. Then at the load center, voltage is stepped down to the required value and automatically maintained at that value. This feature prompts maximum life and optimum performance from the connected equipment.

In addition to lighting, the *Inductrol Power Pack* can be used to regulate the power supply to resistance heating and infrared heating equipment, electronic apparatus, precision instruments and control circuits. The power pack is completely metal-enclosed, permitting its installation outdoors without the expense of fireproof vault. Unit can also be mounted overhead to save floor space.

General Electric Co, Schenectady 5, N. Y.

PRESSURIZED FIRE EXTINGUISHER **P316**

Designed for hazardous metal fires, pressurized fire extinguisher is effective on magnesium, sodium, potassium, zinc, powdered aluminum surfaces. It employs Met-L-X dry powder which fuses to form an air-excluding crust over the burning metal.

Catawissa Unions

PERFECT SEAL

HOT FORGED from solid RECTANGULAR STEEL BARS to give you SURE-FIRE PIPING DEPENDABILITY

A TYPE FOR EVERY USE! **PERFECT SEAL even with pipe not in alignment!**

Standard & Double Extra Heavy **UNIONS**

Available with screwed or socket weld ends. 3000-lb. sizes ⅛" to 3"; 6000-lb. sizes ⅛" to 2".

ORIFICE UNIONS

With screwed or socket weld ends. 3000-lb. and 6000-lb. service.

MALE & FEMALE UNIONS

With steel-to-steel, bronze-to-steel, stainless steel-to-steel or orifice seats. 3000-lb. service only.

FULL STAINLESS & FULL ALLOY STEEL UNIONS

With screwed or socket weld ends. 3000-lb. and 8000-lb. service.

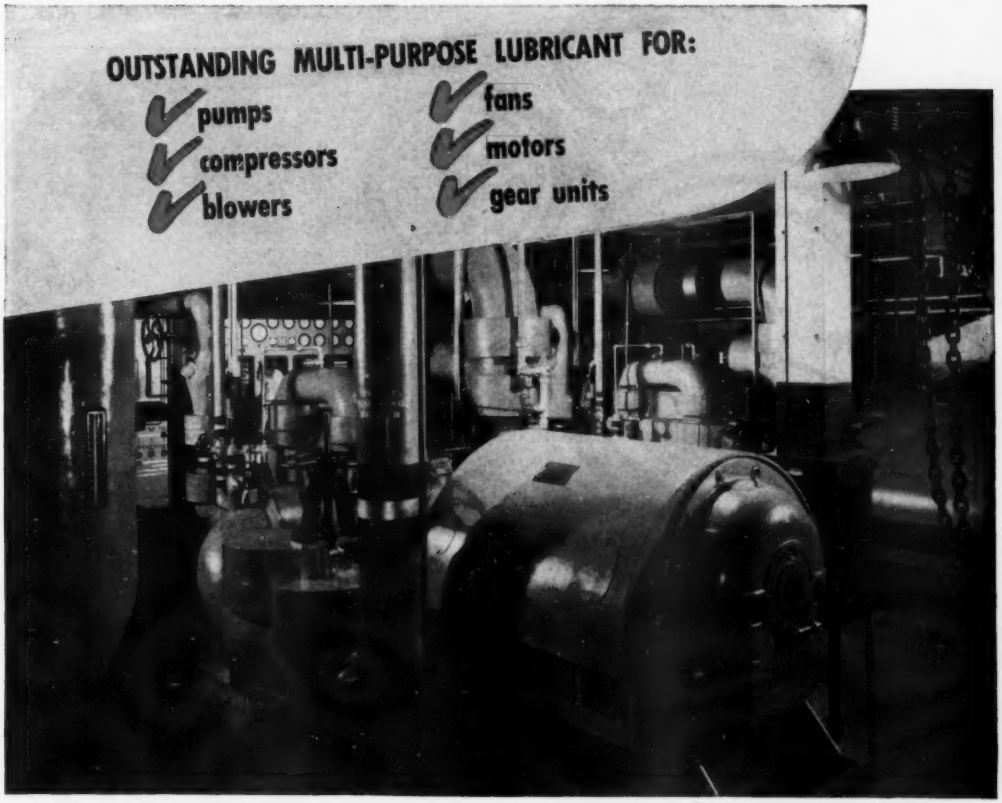
CATAWISSA Ends Guesswork in Union Requirements!

CVF *write for CATALOG 11 showing the complete Catawissa line*

CATAWISSA VALVE AND FITTINGS COMPANY

206 Mill St. • CATAWISSA, PA.

Cut maintenance costs with Gulf Harmony Oil_



Gulf Harmony Oil is a top quality multi-purpose lubricating oil, ideal for sleeve-type bearings, oil-lubricated ball and roller bearings, hydraulic systems, compressor cylinders, and many types of gears.

Because of outstanding oxidation stability, Gulf Harmony Oil has exceptional resistance to sludging. In force-feed circulating systems, oil reservoirs, hydraulic lines, and antifriction bearings, the use of Gulf Harmony Oil helps prevent harmful deposits, insures fewer oil changes.

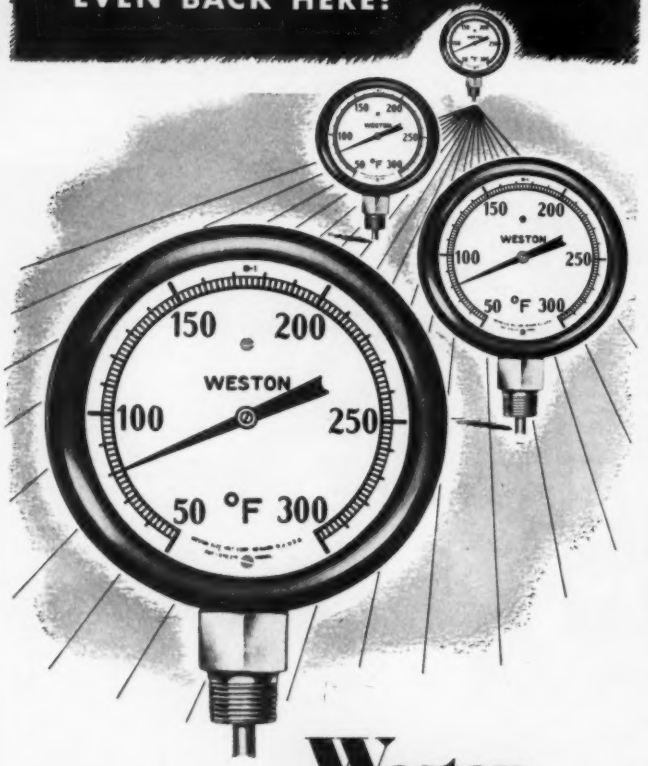
Gulf Harmony Oil provides a protective film which has preferential wetting characteristics for metal—displaces moisture, interrupts its corrosive action. Thus Gulf Harmony Oil eliminates rust on all oil-bathed surfaces—particularly important in antifriction bearings operating under damp conditions. And it separates readily from water, reducing the possibility of emulsification.

Its high lubricating value means more effective protection against wear under boundary conditions. Available in a wide range of viscosities.

For complete information on Gulf Harmony Oil and for expert help on any lubrication problem, call in a Gulf Lubrication Engineer today. Gulf Oil Corporation · Gulf Refining Company, Gulf Building, Pittsburgh 30, Pennsylvania.

FIFTY YEARS OF SERVICE
1901 GULF 1951
PETROLEUM AND ITS PRODUCTS

READABLE . . . INSTANTLY . . .
EVEN BACK HERE!



Weston
All-Metal thermometers

Seconds count when things go wrong . . . wherever temperatures are critical. And not even a split-second is lost in reading temperatures accurately, when the thermometers are WESTON. Their large, boldly marked faces are readable, even from a distance. And the rugged, all-metal construction of WESTON bi-metal thermometers assures dependable, trouble-free operation. Available in types, sizes and stem lengths for most industrial applications. Write for bulletin T-13. Weston Electrical Instrument Corporation, 626 Frelinghuysen Avenue, Newark 5, New Jersey . . . manufacturers of Weston and Tagliabue Instruments.

WESTON *Instruments*

It is moisture-repellent, free-flowing, nontoxic, noncorrosive, and nonabrasive. Its advantages over shoveling soda ash are the following: (1) Stream may be directed by the operator to give uniform coverage. (2) Fires may be fought at a safe distance. (3) Extinguishing agent cannot be contaminated by water since it is sealed in a container.
Ansul Chemical Co, Marinette, Wis.

For more data on these items, use post cards, p.194a. Identify request with P and number.

CORROSION-RESISTANT FITTINGS P325

Speedline corrosion-resistant tube and pipe fittings can be used with corrosion-resistant tubing or pipe in Schd 5S, 10S and 40S. Three principal fittings are an insert flange, aligning connector and a tube or pipe union. Installation time and setting up cost is reduced by these fittings. Specially designed auxiliary fittings like tees, crosses, elbows, etc, are also produced. standard tubing and pipe-sized fittings stocked in several AISI grades of stainless steel and Carpenter stainless No. 20.
Horace T. Potts Co, Erie Ave and D St, Philadelphia 34, Pa.

ELECTRONIC CONTROLLER P351

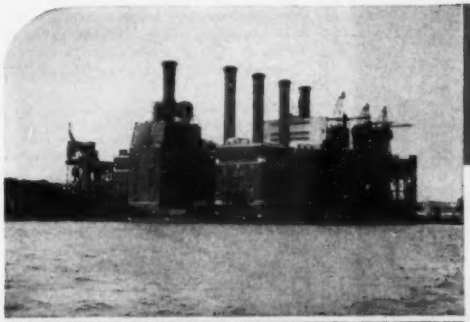
A line of instruments known as the *Cabinet Series* designed to incorporate auxiliary equipment into the case of a direct-reading controller. These instruments are used for measurement, indication, and automatic control of temperature, speed, flow, pressure, etc, including voltage and current.
Wheelco Instruments Co, Chicago 7, Illinois.

VENTILATION FILTER P352

Stamped, heavy steel cell and frame with galvanized screen as a holding form make the new WKE-8, 24x24x8 in. deep, replaceable filter a rugged worker. Filtering medium may be either six or ten-ply feltex paper.
Dollinger Corp, 11 Centre Park, Rochester 3, N. Y.

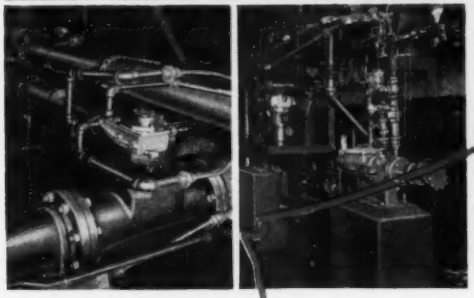
PYROMETER CONTROLLER P353

Anticipatory voltage developed by the *Capaciline*, Model 252 P, fed into the electronic-control circuit of the manufacturer's

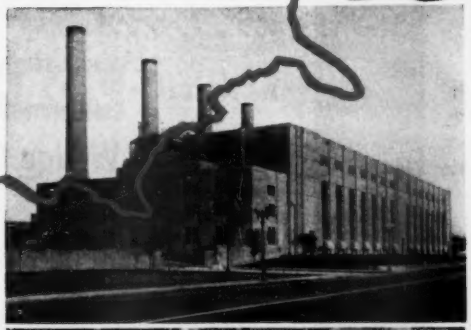


Chemical Treating Equipment for Boiler Water Conditioning

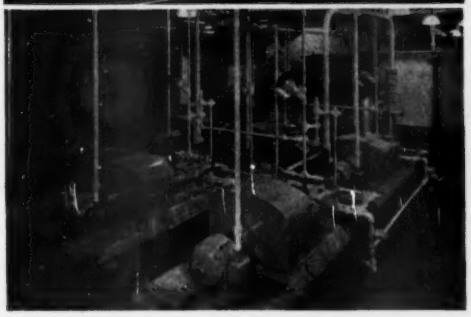
Used by Major Power Plants Across the Country



From coast to coast, %Proportioneers% Chemical Treating Equipment provides modern power plants with an adequate and regular method for treating boilers automatically and in proportion to their service loads. A *necessity* in *large* plants, the %Proportioneers% system also offers many advantages in *small* plants to reduce manpower and give adequate protection.



For the largest high pressure installation or the smallest low pressure job, %Proportioneers, Inc.% can supply feeders, controls, chemical tanks, dissolvers and auxiliary equipment as required—a single responsibility for your complete feeding problem.



Write for Brochure SM 9020
and Bulletin CAT

No. 4 in a series on boiler water conditioning.

% PROPORTIONEERS, INC. %

Write %Proportioneers, Inc.%, 354 Harris Ave., Providence 1, R. I.

Technical service representatives in principal cities of the United States, Canada, Mexico and other foreign countries.

SPECIALLY DESIGNED
for
EASIER INSTALLATION
and
LONGER SERVICE

Fig. 0611, IBBM Wedge Gate Valve, Working Pressures: 125 lbs. Steam, 200 lbs. WOG.

KENNEDY JOB-FITTED

Iron-Body Wedge Gate Valves

YOU SAVE TIME AND MONEY all along the line with Kennedy iron-body wedge gate valves because they are JOB-FITTED . . . every valve specially designed and engineered for the job it has to do.

THE WEDGE DISC is a cored casting of thick metal section, reinforced by integrally-cast interior posts and provided with openings to drain in any position.

HEAVY BRONZE DISC RINGS are forced into dovetailed grooves in the disc in a practically inseparable construction.

HIGHER STRENGTH IRON in the body and bonnet is actually 50% stronger than ordinary cast iron . . . and far exceeds A.S.T.M. requirements.

ALL CONTACT SURFACES between moving parts are bronze-to-bronze to assure easy operation.

RUSTPROOFED STEEL BOLTS AND NUTS have ample clearance to prevent distortion. Open-end wrenches may be used . . . no need for special tools. Valves can be repacked under full pressure.

EVERY FEATURE of the valve helps it do the job better . . . gives you a solid guarantee of economy and dependability whenever you install one of these Kennedy Job-Fitted Wedge Gate Valves.

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WRITE FOR BULLETIN 107

THE KENNEDY
VALVE MFG. CO. • ELMIRA, N.Y.

Est. 1877

VALVES • PIPE FITTINGS • FIRE HYDRANTS

standard *Capacitrol* helps maintain a uniform condition within a heat-treating or process furnace at a relatively low cost.
Wheelco Instrument Co., Chicago 7, Ill.

For more data on these items, use post cards, p.194a. Identify request with P and number.

UTILITY GRINDER **P354**

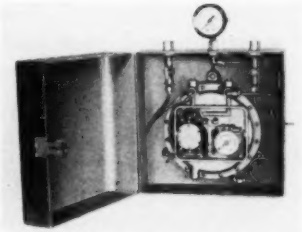
New grinder, Model A, has fast-grinding, long-wearing abrasive wheels, heavy-duty, off-on toggle switch in cast-iron base. Grinder base is rubber mounted and drilled for permanent mounting, with a 7½-ft 3-conductor rubber-covered cable with non-breakable plug. Specifications include fast-starting ¼-hp 3450-rpm motor of dust-proof construction, single-phase, ac, 60-cycle, 115- or 230-v operation. Also available for 2- or 3-phase, ac, 60-cycle, 220- or 440-v service.

Dept AB59, The Lima Electric Motor Co, Lima, Ohio.

BALL BEARING **P337**

Sealed without mechanical contact between its stationary and rotating members, ball bearing combines the advantages of a sealed type with the rotating freedom of an open bearing. It has a capillary chamber formed by the cylindrical extruded section of the inner cover and the tapered section of the inner race. At that point a capillary oil film seals the bearing. Available in bore size of 3 mm (0.1181 in.) to 8 mm (0.3150 in.). Corresponding outside diameters are 10 mm (0.3934-in.) and 22 min (0.8661 in.)

Landis & Gyr, 104-5th Ave, New York 11, N. Y.



VELOCITY CONTROLLER **P306**

Special proportional action velocity controller regulates air velocities leaving the doors of fume hoods, within a range of 50 to 250 fpm. Its present application has been largely in working with radioactive materials where a fixed velocity is required with variable door openings. Device operates on the principle that air velocity moving between two points is proportional to the difference in pressure between those points. Instrument consists of a very light flexible diaphragm operating a pneumatic control mechanism. One side of the diaphragm is at room pressure, and the other is connected to an averaging pressure tip within the fume hood.

Johnson Service Co, 507 East Michigan St, Milwaukee 2, Wis.

PLANT EQUIPMENT NEWS

Reader Service Page for New Products and Literature

Use the handy FREE service cards for additional information on this month's new products or for copies of latest trade catalogs.

BOILERS AND AUXILIARIES

B32 **STEAM GENERATOR**—Bulletin No. SB-33-10M gives informative data on Erie City Keystone packaged-type water tube steam generator. Dimensions, capacities, and diagrams are included. Erie City Iron Works, Erie, Pa.

B33 **SPREADER STOKER**—12-page booklet No. B-4764 relates the evolution of Westinghouse stokers from 1885 to the present time. Also tells the story of Westinghouse Centrafire—its development and application to the modern steam generator. Westinghouse Elec Corp, Stoker Dept, Lester Branch P. O., Philadelphia 12, Pa.

B34 **SOOT BLOWER HEAD**—4-page folder No. 485 describes the new Vulcan P-3 rotary soot blower head for boiler cleaning. Advantages are listed and design features are shown. Vulcan Soot Blower Div, Continental Foundry & Machine Co, DuBois, Pa.

B35 **FEEDWATER CONTROL** — 16-page brochure No. 106-C shows the latest developments in Bailey 3-element feedwater control. Diagrams, cut-a-way views, typical chart records and photographs of modern installations are given. Bailey Meter Co, 1050 Ivanhoe Rd, Cleveland 10, Ohio.

B36 **DUST COLLECTORS** — 28-page catalog contains illustrations and specifications of the complete line of Dustkop pre-tested dust collectors for various types of industrial dusts. Aget-Detroit Co, Ann Arbor, Mich.

B37 **JET PULVERIZER** — 8-page pamphlet No. 2262 presents the Blaw-Knox jet pulverizer, a steam or compressed air operated mill that pulverizes solid materials finer than any other means known to industry. Description of operation, cut-a-way view, and distinctive features are given. Blaw-Knox Co, 2042 Farmers Bank Bldg, Pittsburgh 30, Pa.

COMPRESSORS AND ACCESSORIES

C1 **MOTOR-DRIVEN COMPRESSOR** —24-page booklet No. 726-5 discusses the Class O-CE Chicago Pneumatic horizontal duplex motor-driven compressor having anti-friction roller bearings throughout. Design features are illustrated. Chicago Pneumatic Tool Co, 6 E 44th St, New York 17, N. Y.

C2 **MOISTURE SEPARATOR** — Single-sheet form No. 1180 presents the Aridifier for cleaning and drying compressed air. Capacities, dimensions, prices and installation data are included. Logan Engrg Co, 4901 W Lawrence Ave, Chicago 30, Ill.

CONTROLS, MECHANICAL

E16 **DRAFT CONTROL SYSTEMS** — Three bulletins are offered covering draft control systems. No. 5 is for gas burners; No. 6 for oil burners; and No. 7 for stokers. Applications and wiring suggestions are given. Perfex Corp, 500 W Oklahoma Ave, Milwaukee 7, Wis.

E17 **LIQUID LEVEL CONTROL** — Form No. 7500 presents the Autocon Hi-Level safety switch designed to operate either audible or visual alarms. Suitable for elevated tanks, sumps, vats, industrial processing, etc. Automatic Control Co, 1005 University Ave, St. Paul 4, Minn.

HOW TO ORDER ADDITIONAL DATA

Be sure to fill out, completely, one coupon for each item of information you order. (See sample, right.) This gives your request authority and helps the manufacturer to address your copy completely.

When you have filled out completely one space for each item of information you want, detach along the scored lines and drop the cards in the mail.

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ELECTRICAL EQUIPMENT

F50 **DISTRIBUTION CENTERS** — 8-page catalog No. GEA-6871 covers the G-E Industrol Power Packs for all lighting and power service—15 to 100 kva capacity. Ratings, weights, and prices are given for single- and 3-phase packaged regulating equipment. General Electric Co, Apparatus Dept, Schenectady, N. Y.

F51 **DC MOTORS AND GENERATORS**—19-page booklet No. E-4595 tells about the new Life-Line type BK dc motors and generators. Describes types, enclosures, and mountings for many different applications. Westinghouse Electric Corp, P O Box 2099, Pittsburgh 30, Pa.

F52 **PACKAGED GENERATORS** — 16-page bulletin No. 2160-PRD-202 gives the inside story on the "why" and "how" of E-M packaged generators (3.75-187 kva). Helpful electrical information, charts, graphs, and illustrations are included. Electric Machy Mfg Co, 1351 Tyler St, NE, Minneapolis 13, Minn.

F53 **LIGHTING EQUIPMENT** — 24-page catalog No. MF contains complete line of lighting equipment for slimline fluorescent lamps. Installation data, dimensions, prices, etc, are given. Benjamin Electric Mfg Co, Des Plaines, Ill.

F54 **LIGHT FIXTURES**—4-page folder No. 1050 contains a complete listing of all RLM manufacturers and the RLM-certified lighting equipment made by each. RLM Standards Institute, 326 W Madison St, Chicago 6, Ill.

MAINTENANCE AND SAFETY EQUIPMENT

K24 **OIL FILTERS**—16-page bulletin No. 39041 deals with oil filters, their purpose, makeup, and qualities to be looked for in a filter. A brief history of lubrication is presented. Caterpillar Tractor Co, Peoria 8, Ill.

K25 **LUBRICATION EQUIPMENT** — 14-page 1951 industrial catalog illustrates and describes Universal hydraulic grease fittings, couplers, swivel couplers, control handle for boosting grease pressures up to 12,000 lbs, and top oiler for upper cylinder lubrication. Universal Lubricating Systems, Inc, 791 Allegheny Ave, Oakmont, Pa.

★ **BEARING MAINTENANCE** — Publication, Vol. 1 No. 1, is offered of a continuing study of bearing maintenance techniques and successful maintenance, installation and removal procedures. Filler folder also available. Anti-Friction Bearing Distributors Assn, 1900 Euclid Ave, Cleveland 15, Ohio. (*Write direct on company stationary giving name and title.)

K26 **DRY FIRE EXTINGUISHER** — Technical bulletin No. 9 explains the effect of dry chemical in putting out fires in electric motors and generators. Ansul Chemical Co, Fire Extinguisher Div, Stanton, Marinette, Wis.

K27 **GROUND RESISTANCE** — 32-page booklet No. 35-34 gives informative data on Megger ground testing instruments for measuring resistance of earth to ground connections. James G Biddle Co, 1211 Arch St, Philadelphia 7, Pa.

MAINTENANCE MATERIALS

L44 **LUBRICANTS**—56-page catalog No. 1-50 lists various applications of Lubriplate lubricants for air-conditioning, refrigeration, heating and ventilating equipment, chemical process industries, iron and steel plants, and many others. Product data is also given. Fiske Bros Refining Co, Lubriplate Div, 129 Lockwood St, Newark 5, N. J.

L45 **FLOOR RESURFACING**—Single-sheet form No. L-3784 shows how to use Pak-Tamp to repair or resurface floors. Non-skid, fire and spark-proof. Paramount Industrial Products Co, University Center Station, Cleveland 6, Ohio.

L46 **CORROSION-PROOF LININGS**—Bulletin No. 4-1 describes Atlas' complete line of corrosion-proof linings, including: sheet linings, solution or dispersion linings, brick sheathings, etc. Atlas Mineral Products Co, 42 Walnut St, Mertztown, Pa.

L47 **SPIRAL WOUND GASKETS** — 48-page general catalog includes Ajax spiral wound gaskets and a complete line of metal, metal-asbestos and cut gaskets from any material to standard sizes or to specifications. U. S. Gasket Co, 602 N 10th St, Camden, N. J.

L48 **LEAD-BASE LUBRICANTS**—24-page brochure, commemorating the firm's 75th anniversary, combines both technical data on Brooks lead-base lubricants and historical information about the company. Brooks Oil Co, 824 Ridge Ave, Pittsburgh 12, Pa.

L49 **PLASTER AGGREGATE** — 6-page pamphlet discusses Permalite lightweight plaster aggregate. Recommended mixes and applications are given. Great Lakes Carbon Corp, Building Products Div, 18 E 48th St, New York 17, N. Y.

L50 **REFRIGERATION COMPRESSOR PACKINGS**—4-page folder No. CE-1 tells how to pack a refrigeration compressor, with blue prints of centrifugal and reciprocating installations. A W Chesterton Co, 6 Ashland St, Everett 49, Mass.

MATERIALS HANDLING

M23 **PALLET TRUCK**—16-page booklet No. BP-4 features the Towmotor Model W electric pallet truck—capacity 4000 lbs. Dimensional specifications, diagrams, and advantages are given. Towmotor Corp, 1226 E 152nd St, Cleveland 10, Ohio.

M24 **CHAINS AND SPROCKETS**—Catalog No. A418 covers complete line of chains and sprockets for both new and replacement service on elevating and conveying equipment, and for drives. 22 types of malleable, steel and alloy chains, as well as many types designed for special requirements, are shown and described in detail. Jeffrey Mfg Co, 963-99 N 4th St, Columbus 16, Ohio.

M25 **LIFT TRUCK ACCESSORIES** — 4-page folder No. SP-6 pictures the various standard Towmotor accessories for mass handling of unusual materials and special types of loads. Towmotor Corp, 1226 E 152nd St, Cleveland 10, Ohio.

MECHANICAL TRANSMISSION

N25 **BALL BEARINGS**—Catalog simplifies and illustrates, by examples, selection of bearing type and size for various conditions of load and speed. Load rating tables give both radial and

(Continued on page 196)

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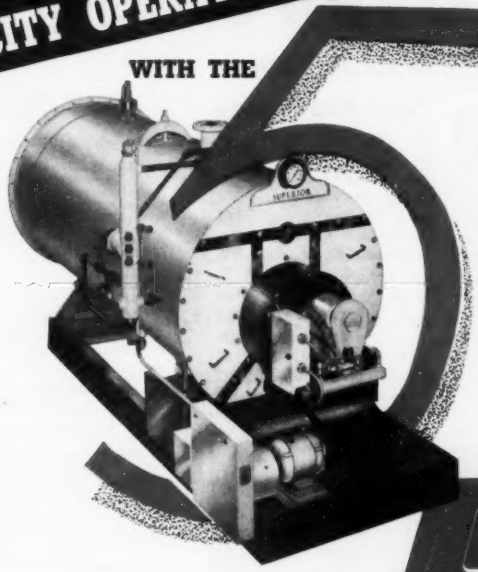

5 Sq. Ft.

OF HEATING SURFACE
PER B.H.P.
IN EVERY

SUPERIOR
STEAM GENERATOR

A good steam generator doesn't have to be pushed . . . it attains its maximum rated capacity with ease. Superior Steam Generators do just this and at thermal efficiencies in excess of 80% under field operating conditions. One of the main factors contributing to their full capacity operation at high efficiencies is the five square feet of heating surface per b.h.p. in every Superior Steam Generator.

High efficiencies developed on the job result in lower fuel costs. These same high efficiencies developed easily without pushing the steam generator result in lower maintenance costs and longer boiler life. The final result of course, is lower steam costs.

There are other features which contribute to the outstanding performance of Superior Steam Generators . . . multiple-fan induced down-draft which is built-in, combined with Superior 4-pass construction for higher efficiency . . . large evaporating surface for quick steaming . . . large steam space and dry pan to assure ample reserve steam capacity and 99.5% dry steam at the nozzle . . . and many other important features, each painstakingly developed through experience and research, to make a Superior Steam Generator the unit to cut your steam costs.

Superior Steam Generators are completely factory assembled, backed by undivided responsibility. Burn gas or oil, or both. Manufactured in 18 sizes from 20 to 600 b.h.p. for pressures up to 250 p.s.i. or for hot water.

Write today for the details in Catalog 301.

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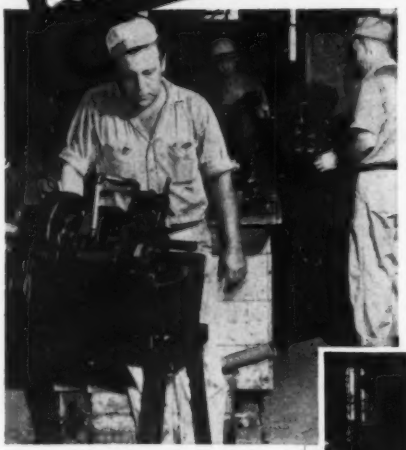
Factory, Emmaus, Pa.
Executive Offices, Times Tower, Times Square, New York 18, N. Y.

"Long life... Low upkeep!" ...say users of

TOLEDO

2" Portable Power Pipe Machines



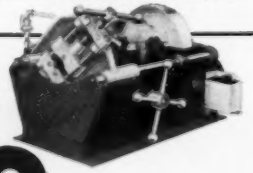
20 YEARS! "These two Toledo #999 Machines have been in continuous hard service for more than 20 years with only routine service attention," says P. E. Hayes of J. M. Hengy Electric Co., Dallas, Texas. "All our pipe threading tools, both power and hand, are and will be Toledo." Photo taken on Dallas Power and Light Co. job.

Speed Production...

It's *5 times faster than hand methods* — this rugged-performing TOLEDO No. 999 2" Power Pipe Machine! Job-proved by thousands of users—progressive outfits like the Texas contractors described above. A machine that's *right* for your high-production needs today!

Threads 2" pipe in 22 seconds ... cuts off 2" pipe in 10 seconds. Compact... portable... efficient... use it anywhere in your shop, plant or on the job. Your choice—Wheel or Knife Cut-Off. Toledo-built with the know-how of nearly 50 years... assuring *long life... low upkeep.* Write for catalog. The Toledo Pipe Threading Machine Co., Toledo, Ohio. New York Office: 165 Broadway, Room 1310.

25 MACHINES! Tooled for high production — Farwell Company, Inc., plumbing and heating contractors in Dallas, Texas, have 15 Toledo #999 Machines, 5 Toledo 2" High Speed Machines and 5 Toledo #1-2-4 Power Pipe Machines. Photo shows work on Southern Methodist University job.



RELY ON THE LEADER

TOLEDO

PIPE TOOLS ... POWER PIPE MACHINES ... POWER DRIVES

thrust capacities for all bearings except those types which are designed for specialized services. New Departure Div, General Motors Corp, Bristol, Conn.

N26 **CHAIN DRIVE**—Handbook No. ARC-51-PR is packed with suggestions on how to install, maintain and operate roller chain. Tells how to plan chain drive layouts; offers hints on lubrication and roller chain selection. Atlas Chain & Mfg Co, Kensington & Custer Aves, Philadelphia 24, Pa.

METERS AND INSTRUMENTS ELECTRIC

S9 **STRIP CHART RECORDERS** — 4-page folder No. C2-2 describes the Wheelco Capacilog line of electronically operated strip chart recorders. Model numbers and specifications of various recorders and recorder-controllers are given. A separate price list supplement is also included. Wheelco Instruments Co, 847 W Harrison St, Chicago 7, Ill.

S10 **THERMOCOUPLES, PYROMETERS** — 56-page catalog No. P1238 contains thermocouple and pyrometer accessories. Tables of calibration data for the commonly-used base metal and rare metal thermocouples are included. Bristol Co, Waterbury 20, Conn.

METERS AND INSTRUMENTS MECHANICAL

T24 **WATER LEVEL GAGES** — 24-page booklet No. L700 describes float, pressure bulb, pressure, counterpoise, differential pressure, and air-bubbler types of liquid level gages for a variety of uses. Applications of the instruments to chemical processing operations involving solutions, suspensions, and organic liquids are included. Bristol Co, Waterbury 20, Conn.

T25 **FLOW INDICATOR** — 12-page bulletin No. 42 features the firm's new V/A Cell Kinetic manometer, a compact flow indicator and transmitter unit developed for differential pressure applications. Diagrams show typical installations. Fischer & Porter Co, 42 County Line Rd, Hatboro, Pa.

T26 **RESONANT REED TACHOMETERS** — 16-page pamphlet No. 31-24 discusses Frahm resonant reed tachometers for hand use or permanent mounting. Operate without direct contact with moving parts under test. Price sheet is included. James G Biddle Co, 1316 Arch St, Philadelphia 7, Pa.

T27 **TELEMETERS** — Folder No. DMO29 contains information on the use of the company's Metameter telemeter for remote measurement and automatic control of temperatures, pressures, rates of flow, liquid levels, etc, over distances ranging from a few feet to many miles. Bristol Co, Sales Prom Dept, Waterbury 20, Conn.

PIPING, FITTINGS, VALVES AND SPECIALTIES

U47 **DROP FORGED STEEL VALVES** —400-page book No. F-9 is full of new and improved drop forged steel valves and fittings, and flanges, for every modern piping need at high or low pressures and temperatures. A refrigeration section is included in the back of the book. Henry Vogt Machine Co, 10th & Ormsby Sts, Louisville 10, Ky.

U48 **MECHANICAL TUBING** — Data card No. 1150 consists of a table on tolerances for round seamless carbon and alloy steel mechanical tubing, giving permissible variations in diameter and wall thickness. Babcock & Wilcox Tube Co, Beaver Falls, Pa.

U49 **FLEXIBLE BALL JOINTS** — 16-page catalog No. 215 covers Barco flexible ball joints. General description, service information, pressure rating charts and dimensions are given. Barco Mfg Co, Dept J-66, 1801 Winnemac Ave, Chicago 40, Ill.

U50 **CORRUGATED METAL PIPE** — 16-page booklet, entitled "Armco Corrugated Metal Pipe—A Type for Every Need," lists the types of full-

ALLIS-CHALMERS

Hot Process—Hot Zeolite SYSTEM

..Offers ALL SIX!

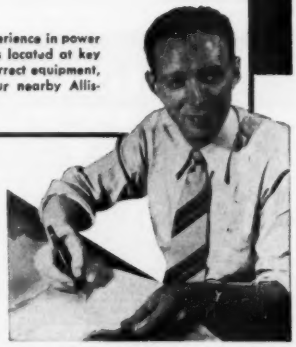
1. Zero hardness **4.** Low total solids

2. Low alkalinity **5.** Optimum pH

3. Low silica **6.** Low CO_2 in steam

PLUS: Simplicity of operation and low chemical costs!

LAWRENCE A. PEDERSEN, with over 17 years experience in power plant water conditioning, is one of the specialists located at key points throughout the country to advise you on correct equipment, chemicals and service. For free survey call your nearby Allis-Chalmers office.



CONVENTIONAL TREATING METHODS seldom produce a completely satisfactory boiler feedwater. Each method leaves power equipment unprotected in some way. Treating equipment selection normally is made on the basis of the *least* harmful effluent.

That is where Allis-Chalmers comes in. We know power equipment because we manufacture it, and we know how vital good water is to its performance. Now we insure that performance by offering the hot process — hot zeolite system, which gives complete control over *all six* critical water conditions.

Only a hot process — hot zeolite system obtains *low hardness* while reducing *alkalinity, silica, solids* and *CO_2 in the steam.* At the same time it raises *feedwater pH* to optimum values. There is no compromise of essentials with this combined treatment. Yet *chemical costs are low,* for only salt and lime are required for operation.

Guard against scale, embrittlement, foaming, carryover, corrosion and excessive blowdown with one system! Investigate the possibilities of hot process — hot zeolite treatment. Write for the free Allis-Chalmers bulletin 28X7559.

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Water Conditioning

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Hendrick Open Steel Flooring

has rectangular, square-edge steel bars that provide a non-slipping, level walking surface . . . 90% open area for light and ventilation . . . great strength to support heavy loading, without any lateral deflection of bars . . . no bolts, rivets or angle irons to loosen, or to collect dirt and refuse . . . no welds, with residual stresses that lead to warping.

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Mitco Open Steel Flooring,
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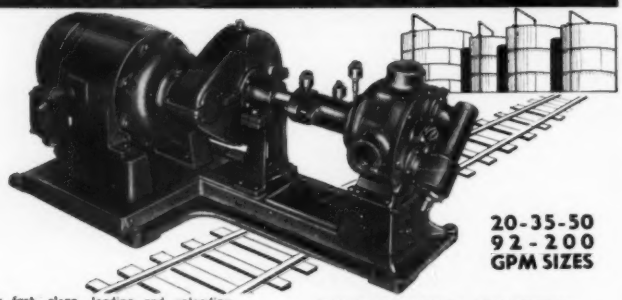

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92-200
GPM SIZES

For fast, clean, loading and unloading of petroleum products and other liquids up to 11,000 S.S.U. Ideal for installing out of doors without protection of any kind.

Reduce your pumping time with these big, rugged units. Built to take it.

OUTSTANDING FEATURES:

1. A complete range of sizes. See capacities listed at left.
2. New, oil-tight, cast iron gear case. No leakage.
3. Radial bearing for pump shaft on 200 gpm size. Bronze bushed bearing for smaller sizes.
4. Stainless steel pump shaft. No rusting.
5. Viking valve on pump head. (Optional)
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7. Speed and capacity range available for each size pump.
8. Five ball check grease cups. (Other style grease fittings optional.)
9. Complete unit totally enclosed for outside use without protection of any kind when equipped with totally enclosed motor.

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Viking PUMP COMPANY
Cedar Falls, Iowa

round pipe and Pipe-Arch available for various types of sewers, culverts, conduits or irrigation systems. Armco Drainage & Metal Products, Inc, Middletown, Ohio.

U51 **REDUCING VALVE** — 6-page bulletin No. W-3 contains complete technical information on Golden-Anderson's cushioned water pressure reducing valve. Installation, operation, adjustment, servicing and specifications are fully described. Golden-Anderson Valve Specialty Co, 2070 Keenan Bldg, Pittsburgh 22, Pa.

U52 **LIGHT-WEIGHT PIPE**—4-page folder No. 507 shows typical applications of Naylor Lockseam Spiralweld pipe in the construction, dredging, materials handling, paper mill, power plant, etc, fields. Includes data on fittings, flanges, connections, and pipe specifications. Naylor Pipe Co, 1230 E 92nd St, Chicago 19, Ill.

U53 **DRAINAGE MANUAL**—46-page manual is presented to assist construction engineers, superintendents, and foremen in the proper methods of installing Armco drainage structures, culverts, sewers, or conduits. Armco Drainage & Metal Products, Inc, Middletown, Ohio.

U54 **VALVES**—112-page catalog No. 50V covers the entire Stockham line of bronze and iron body valves. Photographs, dimensional diagrams, price, weight, and sizes are listed. A section is devoted to accessories and essential engineering data. Stockham Valves & Fittings, Box 2592, Birmingham 2, Ala.

PRIME MOVERS

V9 **TURBINE-GENERATORS** — 40-page booklet No. H-18 describes and pictures nearly 50 turbine-generator installations, both utility and industrial. Brief discussions of generator and exciter cooling methods are included. Elliott Co, Jeannette, Pa.

V10 **DIESEL ENGINES** — 28-page bulletin No. 187 gives design data on Nordberg 2- and 4-cycle stationary and marine diesel engines, gasoline marine engines, Symons cone crushers and screens, mine hoists, air and gas compressors, etc. Nordberg Mfg Co, 3073 S Chase Ave, Milwaukee 7, Wis.

WATER TREATMENT

X21 **CORROSION INHIBITOR**—Leaflet No. 25X7582 explains the manner in which Allis-Chalmers No. 160 Series corrosion inhibitor acts by neutralization and by surface absorption to control the corrosion of steam and condensate lines. Allis-Chalmers Mfg Co, 952 S 70th St, Milwaukee, Wis.

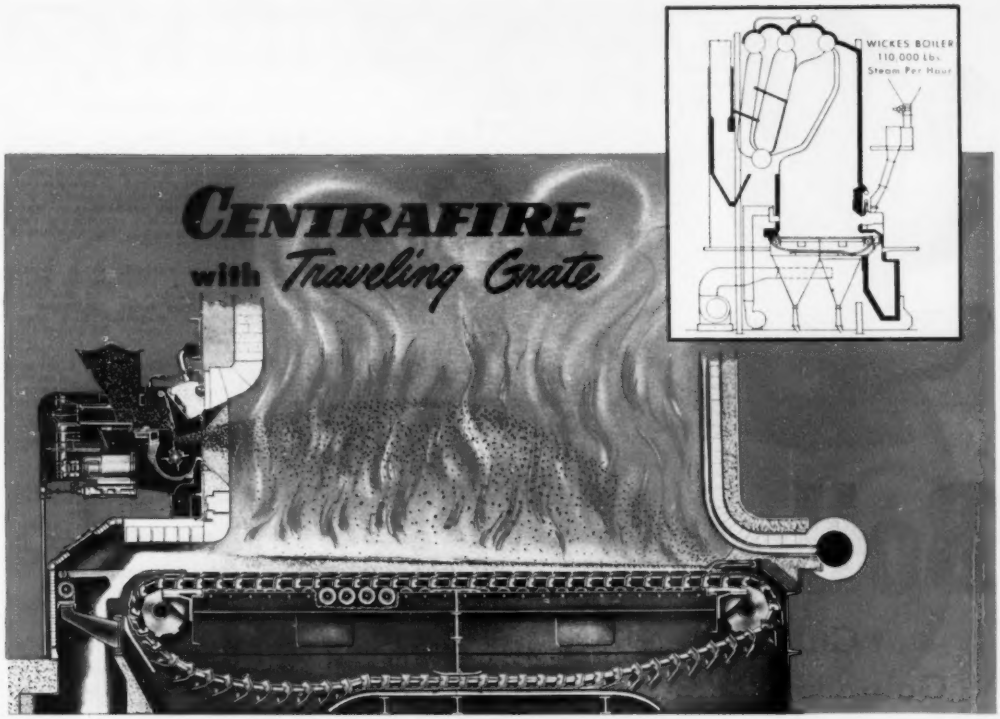
X22 **PRECIPITATING SOFTENER** — Bulletin No. W-212-B6 discusses the Type CM precipitating softener and coagulator, in which energy for floc preparation is mechanical. Also describes the flow circuit, diagrams the flow, and answers 9 questions in a system appraisal. Worthington Pump & Machy Corp, Harrison, N. J.

X23 **TEST KIT**—4-page folder No. 2RE50 features equipment and reagents for conductometric determination of solids in boiler water and steam. A quick and simple method for determining the solids content is described and illustrated. Hall Laboratories, Inc, Hagan Bldg, Pittsburgh 30, Pa.

X24 **CEMICAL FEEDERS** — 12-page publication No. RP-9080 describes both dry and solution systems of feeding chemicals to closed vessels such as boilers and chemical mixing tanks. %Proportioneers, Inc,% P O Box 1442, Providence 1, R. I.

X25 **WATER DEMINERALIZER** — Folio contains catalog sheets and other pertinent information regarding Penfield ion exchange systems ranging in capacity from 30 to 1,000 gph. Penfield Mfg Co, Inc, 19 High School Ave, Meriden, Conn.

X26 **WATER TREATMENT** — Two folders are offered. One deals with the treatment of condenser water. The other tells about Luminite boiler



....brings Extra Engineering Refinements to Spreader-Type Firing

The outstanding performance of the Centrafire® with Traveling Grate stems from features that are built in —not added as accessories.

A positive, metered flow of coal, wet or dry, is fed continuously by an air-cooled overthrow rotor into the combustion area. Proper distribution is effected automatically by cyclic control of the rotor speed.

All moving elements are hydraulically operated by one turbine—or motor-driven oil pump. This assures infinite flexibility through the complete range of operation—synchronizes coal feed and grate speed.

Grates are plate-type, laboratory tested under conditions far more severe than those of actual service conditions. Roller-supported grate chains reduce friction and power requirements.

Fuel distribution adjusted automatically to air flow through front and rear grate sections results in intimate mixing of fuel and air for thorough combustion.

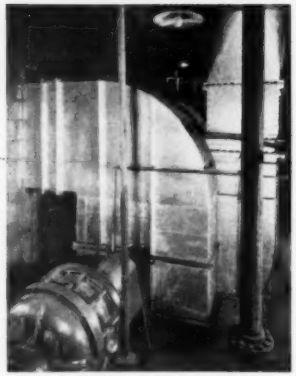
The Centrafire's range extends upward of 300,000 lbs. of steam per hour. Its adaptability to deep, narrow furnaces permits use of the most economical boilers.

Ask your Westinghouse representative for complete data, or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-50522

YOU CAN BE SURE... IF IT'S
Westinghouse
STOKERS

Boiler Gases

at Calco Go on Green



Twenty odd years ago, a new boiler was installed at the Calco Chemical Company's plant at Bound Brook, New Jersey. The induced draft and forced draft fans carried the 'Green' nameplate.

Five years later, another new boiler was installed at the same plant—a different make of boiler. Again the induced draft and forced draft fans selected were 'Green.'

Specifications for each of the Green Induced Draft Fans, called for 88,000 cfm maximum load at 350°F against 9" (water gauge) static pressure at 570 rpm.

Calco has an outstanding boiler plant and here as in so many other important boiler plants, Green Fans carry the load. They're soundly designed and strongly made. They give satisfactory service. Look into their values for your fan requirements.

THE GREEN *Fuel Economizer* COMPANY INC.

BEACON 3, NEW YORK

ECONOMIZERS • FANS • AIR HEATERS • CINDERTRAPS

water treatment, a coagulant treatment formulated to the customer's specifications, after an inspection and survey of operating conditions. Warren Refining & Chemical Co, 750 Prospect Ave, Cleveland 15, Ohio.

OTHER EQUIPMENT

Z48 **SPRAY NOZZLES** — 8-page brochure No. 6A-SP furnishes details of design, application, construction, and operation of SK spray nozzles. Pictures recooling spray nozzle systems for use in plants which operate condensers or use large quantities of water for cooling. Schutte & Koerting Co, Dept J-D, Cornwells Heights, Bucks County, Pa.

Z49 **ENGINE COOLERS** — 4-page folder No. 1651 shows Young Mono-Weld radiators having one-piece and sectional-type cores. Designed for heavy-duty gas, gasoline and diesel engine cooling. Young Radiator Co, Racine, Wis.

Z50 **PUMPS**—Bulletins No. S-204 and Q-50 illustrate and describe Warren-Quimby screw and Rotex pumps, recent additions to the firm's line of centrifugal and reciprocating pumps. Both are built in 2 standard types, gear-in-head and external gear and bearing. Warren Steam Pump Co, Inc, Warren, Mass.

Z51 **STEEL FLOORING** — 16-page catalog No. 1103 discusses different types of Tri-Lok open steel flooring and safety treads. Contains specification data, safe load tables, installation methods and other pertinent information. Dravo Corp, Machinery Div, National Dept, 5th & Liberty Aves, Pittsburgh 22, Pa.

APPOINTMENTS

Three new sales representatives have been named to **Allis-Chalmers** general machinery division district offices. They are: Thomas C Smith, Milwaukee; E E Strickland Jr, New York; and Elwood C Gerber, Pittsburgh. V G Murdock and J V McGuire have become engineers in charge of sales of apparatus and unit substation groups, respectively, of substation section. Also, John F Costigan has been made assistant works manager of the company's Norwood, Ohio works.

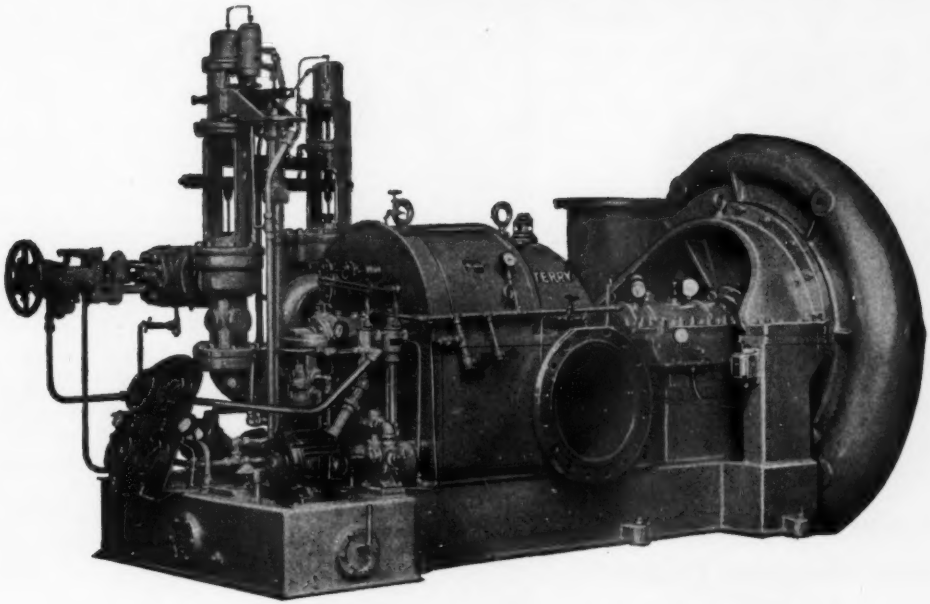
Babcock & Wilcox Co appoints S T Mackenzie to newly created post of sales manager, with headquarters in New York. R W Buntin replaces Mackenzie in Philadelphia district office as sales manager. Frank E Hutton assumes position of executive assistant in charge of application and sales of heat and chemical recovery equipment, etc, for the pulp and paper industry.

Fire protection engineer David C Timberlake, formerly with Underwriters' Laboratories, has joined the engineering dept, Fire Extinguisher Div, **Ansul Chemical Co,** Marinette, Wis.

Philip Carey Mfg Co, Cincinnati, Ohio, promotes L Charles Underwood to assistant advertising manager.

Walter L Davidson is named sales manager for heating dept of **Dravo Corp.** His headquarters will be in the Dravo Bldg, Pittsburgh. Henry G Fieger becomes shop manager for the firm's fabricated piping plant at Marietta, Ohio. In addition, A J Morrison, manager, shaft and tunnel dept, is elected chairman of junior board of directors for 1951. Others ap-

The TERRY TURBINE



SPECIAL PURPOSE TURBINE

FOR OPERATION UNDER ALL THESE CONDITIONS:

1. Straight, high-pressure, condensing
2. Straight, low-pressure, condensing—putting to work excess low-pressure steam.
3. Mixed pressure — using the low-pressure steam available, with only enough high-pressure steam required to drive the compressor
4. Condensing bleeder operation — providing clean, low-pressure steam for heating or process work

. . . and the speed under any of these conditions can be varied from 2800 to 4750 rpm.

This is but one example of many unusual combinations developed by Terry to meet out-of-the-ordinary requirements in turbines up to 2000 hp. Information on a special-purpose turbine for your specific requirements will be gladly furnished.

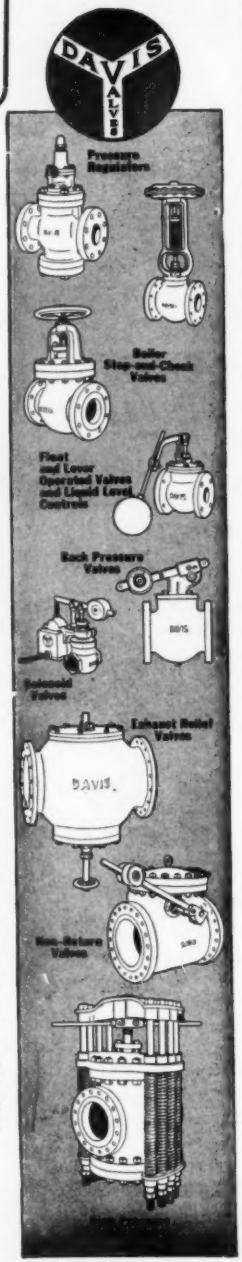
T1177

THE TERRY STEAM TURBINE COMPANY
TERRY SQUARE, HARTFORD, CONN.

BASKET TYPE
STRAINERS

Sizes:
½" to 14"

DAVIS
No. 76
STRAINER



- *Large Strainer Area!*
- *Low Pressure Drop!*
- *Easily Cleaned!*

DAVIS Basket Type Strainers are used extensively on pressure and suction pipe lines carrying water, oil and other fluids for the protection of meters, pumps and other equipment. The No. 76 Strainer has a cylindrical basket with perforated sides and bottom. A flange at the top of the basket supports it in the Strainer. The flow enters the basket through the top. When the cover is removed the basket may be lifted out easily for cleaning. Body passages and screen have areas in excess of pipe of corresponding size, which reduces the pressure drop across the strainer to a minimum. Free screen area is from 2½ to 4½ times pipe area depending on size of perforations. The recommended size of screen perforations depends on the fluid being strained and the foreign matter in suspension.

Take advantage of
Davis' 76 Years of Experience!
Ask for recommendations.

DAVIS REGULATOR CO.

Representatives in All Principal Cities

2540 S. WASHTENAW AVENUE, CHICAGO 8, ILLINOIS

pointed to the board are: William D Bickel manager, power dept; Louis P Sturbel, manager, Keystone Div; and William H Collin, director of advertising.

Dampney Co assigns Howard N Verrault as branch manager of its Chicago office at 53 W Jackson Blvd.

W A Neumann Jr has been promoted to manager of IMO-De Laval Products Div, **De Laval Steam Turbine Co.** In addition to his new duties, Neumann will continue as assistant treasurer of the company. E W Clark has been made controller.

Eriez Mfg Co, Erie, Pa., appoints C D Sutton, Inc, as the Eriez representative in Los Angeles, Calif. area. Sutton will handle the firm's complete line of all permanent magnetic separation equipment of its own manufacture, Memco electromagnetic separation equipment and RCA electronic metal detectors.

Bruce K Stabelfeldt joins **Edward Valves, Inc,** East Chicago, Ind., as advertising and sales promotion manager.

Joseph H Bertram & Co, 209 Washington St, Boston, Mass., has been selected sales representative for **Kieley & Mueller.** Territory includes all of New England except Connecticut.

Link-Belt Co announces personnel changes as follows: Andrew K Kolar is now assistant sales manager for Pershing Road plant products, with office at 300 W Pershing Rd, Chicago. Stuart T Penick succeeds Kolar as district manager at Moline, Ill. Charles W Beauchamp is appointed assistant sales manager for silent and roller chain, and H Merrill Bowman, assistant sales manager, general products, at the Ewart plant in Indianapolis.

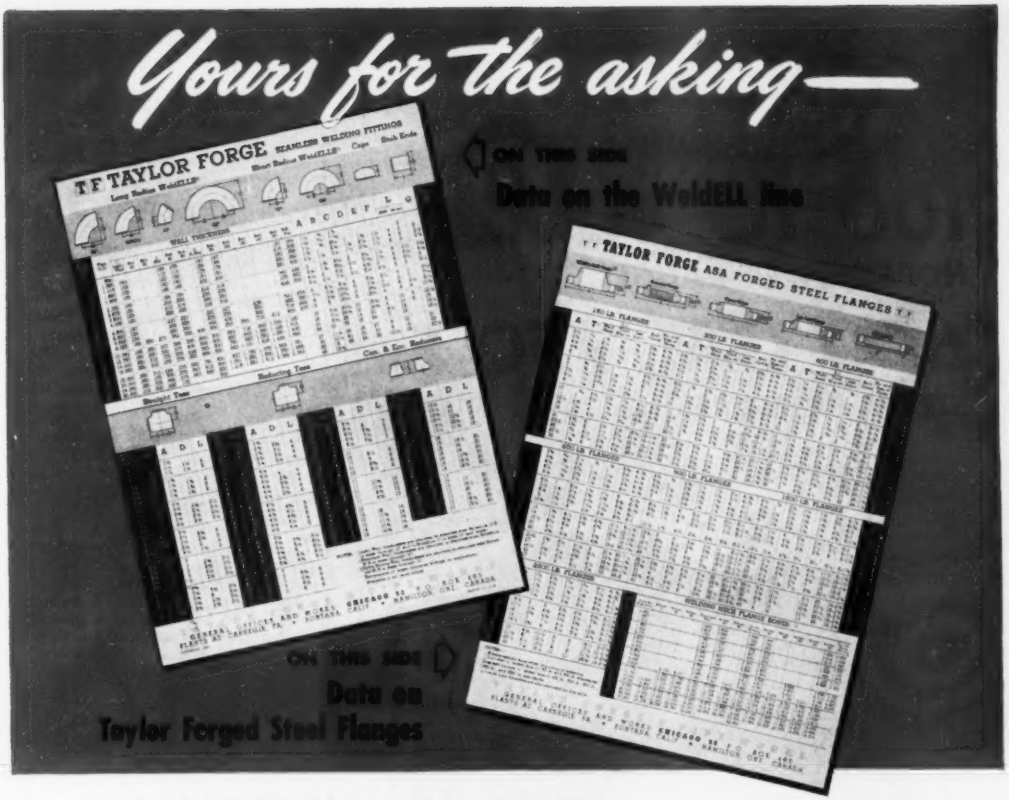
Consolidated-Ashcroft-Hancock Div, **Manning, Maxwell & Moore, Inc,** has named Robert E Mason director of mobilization planning, and Leslie T Willard works manager, of the combined Bridgeport and Stratford, Conn., plants.

Charles W Jinnette, **Norton Co's** regional manager of business planning and development, has retired after more than 50 years of active service with the firm. Edwin E McConnell and Lewis S Greenleaf Jr have been elected members of the board of directors. Thomas S Green, a director for 13 years, has retired.

Nordberg Mfg Co, Milwaukee, Wis., assigns Francis W Cross to its Heavy Machinery Div as sales engineer. Dakota Electric Supply Co, 1017-1023 Fourth Ave, N, Fargo, N. D., will be distributor for Nordberg 4FS diesel engines in the states of North and South Dakota, northwestern Minnesota and northeastern Montana.

Stanley F Heller & Son, Stroudsburg, Pa., will act as distributor for **Plibrico Jointless Firebrick Co** throughout northeastern Pennsylvania.

Establishment of a company-operated sales office to service northeastern Ohio area is announced by Power Plant Equip Div,


Yours for the asking—
T F TAYLOR FORGE SEAMLESS WELDING FITTINGS
ON THIS SIDE
Data on the WeldELL line
T F TAYLOR FORGE ASA FORGED STEEL FLANGES T F
ON THIS SIDE
Data on
Taylor Forged Steel Flanges

A VOLUME OF DATA

. . . covering welding fittings and forged steel flanges . . .

ON A SINGLE SHEET

Here is just about the handiest tool ever devised for the pipe designer. Data on welding fittings and flanges that otherwise could be found only by plowing through many catalog pages and tables have been ingeniously condensed on the two sides of the durable letter-size card illustrated above.

One side covers the broad WeldELL line of Taylor Forge welding fittings. For every nominal pipe size, ½" through 30", it shows the wall thickness for every weight of every fitting in every available material. It also shows all required dimensions of all types of fittings.

The other side covers the world's most complete line of forged steel flanges. For every nominal pipe size, ½" through 24", it gives all essential dimensional and bolting data for all types of flanges in all weights. A particularly useful table (see reproduction) is that showing welding neck flange bores which enables you to determine the I.D. of any nominal pipe size without separate calculation. Thus the sheet gives you O.D. and I.D. of any weight of pipe.

The card is varnished to make it stand the steady usage you are certain to give it. To obtain your copy see your Taylor Forge distributor or **MAIL THE COUPON.**

T F

TAYLOR FORGE

TAYLOR FORGE & PIPE WORKS

General Offices and Works: P. O. Box 485, Chicago 90, Ill.
Offices in all principal cities.
Plants at: Carnegie, Pa.; Fontana, Calif.; Hamilton, Ont., Canada

Please send me one of your fitting and flange sheets:

NAME_____

POSITION_____

COMPANY_____

STREET ADDRESS_____

CITY_____ ZONE____ STATE_____

501-0351 Mail to Taylor Forge & Pipe Works, P.O. Box 485, Chicago 90, Ill.

ECONOMY

AT MODERATE INITIAL COST

100 TO 4000

HORSEPOWER RANGE

600# GA., 750° F.

STEAM PRESSURES

MURRAY

STEAM TURBINES

TYPE UV MULTISTAGE

The Type UV Multistage Turbine is available in from two to ten pressure stages making Multistage steam economy available at moderate initial cost. Horsepower range is from 100 to 4000, steam pressures up to 600# ga., 750° F., condensing or non-condensing. Several governors and accessories adapt UV Turbines to practically any mechanical drive within the capacity range.

Pictured is a 5 Stage UV Turbine developing 325 HP at 6200 RPM operating condensing. Turbine is equipped with variable speed oil relay governor, pressure lubrication and vacuum breaker, and is in use driving a centrifugal compressor for refrigeration.

Contact your Murray representative for prices and engineering information or write for Bulletin T-122.

MURRAY IRON WORKS COMPANY

BURLINGTON, IOWA

BUILDERS OF STEAM POWER EQUIPMENT FOR THREE QUARTERS OF A CENTURY

Swartwout Co. Under direction of district manager Harold C Douda, the office is located at 18511 Euclid Ave, Cleveland, Ohio.

Frank Hallberg has been made chief engineer of **Ross Operating Valve Co,** Detroit. Domenic A DiTirro has been named to head up the sales and technical service engineering divisions.

Republic Rubber Div, Lee Rubber & Tire Corp, assigns C Russell Conklin to take over management of **Republic's** Philadelphia office at 22nd & Race Sts. Warren Ingersoll, formerly in charge of this office, will now devote all his time to duties as assistant to the president of the Lee Corp. Ingersoll will be located at the corporation's main office in Conshohocken, Pa. Ray L Beveridge will also headquarter at the Philadelphia office as field engineer for Republic.

Westinghouse Electric Corp reports personnel changes as follows: Bruce D Henderson is now general purchasing agent. W G Miller becomes manager of manufacturing for motor and control div, Buffalo, N. Y. A M Harrison succeeds Clarence Lynn as manager of dc engineering dept of transportation and generator div at East Pittsburgh. Lynn is now with the firm's Atomic Energy Div. Frank E Bodine replaces W P L'Hommedieu as manager of central station div for Pacific Coast district. L'Hommedieu is promoted to assistant Pacific Coast district manager, with headquarters at San Francisco.

Robert T Haslam has been elected to the board of directors of **Worthington Pump & Machy Corp,** Harrison, N. J. Hutchinson Foundry & Steel Co, Hutchinson, Kansas, has been made distributor for the company's construction equipment in south central Kansas area. **Worthington-Gamon Meter Co,** Newark, N. J.,—formerly a subsidiary of Worthington Pump & Machy—has been made a division of that corporation. The new division will continue the manufacture of liquid meters at the former company's plant in Newark. Robert R Anderson, formerly president, Worthington-Gamon, has been elected vice-president of Worthington Pump and will act as general manager of the new division. William C Flanders, formerly vice-president of the meter company, has been appointed assistant general manager of the division and Walter H Zeis, formerly secretary and treasurer of the meter company, has been elected assistant secretary of the Worthington corporation.

Weston Electrical Instrument Corp, Newark, N. J., names Arthur L Morrison purchasing agent to succeed George T Deaney who is now war activities coordinator. Thomas H Closs becomes sales representative for northeastern and eastern Maryland. Closs will maintain offices in metropolitan Baltimore at 17 W Pennsylvania Ave, Towson, Md.

General Electric Co announces personnel changes as follows: David C Prince is named to president's staff, with special duties as assigned. Harry A Winne assumes Prince's responsibility for general engineering laboratory. Ernest E Johnson

Specifications SPEAK LOUDER THAN ADJECTIVES

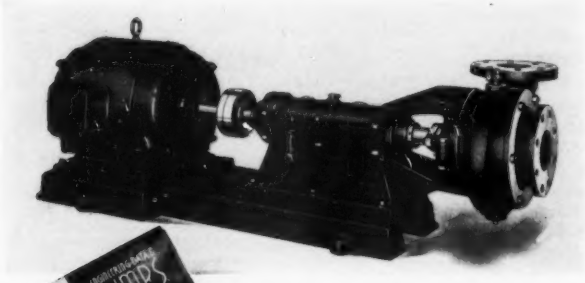
SPECIFICATIONS — BUFFALO FULL BEARING PUMPS

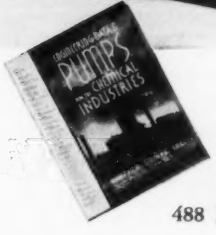
Casing: Solid shell volute type with removable suction side plate. Male and female fit insures perfect alignment of casing with supporting housing. Casing can be revolved before or after leaving the factory to give at least four different positions of openings. Unless otherwise requested, pumps are arranged with vertical up discharge. Can be furnished either rotation. **Wearing Rings:** Easily renewable wearing rings, protect casing from wear. **Impeller:** High efficiency enclosed type with liberal openings to pass abrasive solids. Enclosed impeller construction eliminates wear on the pump casing. Impeller mounted on shaft by feather key and lock nut and screw. Open impeller can be furnished where necessary, in which case wearing rings are omitted. **Bearing Housing:** Supporting head and bearing housing cast integral and bored at same operation insuring permanent alignment. Large oil

in "Buffalo" PUMPS

FOR ALLOY CONSTRUCTION

• A look at the specifications tells of the fine quality construction of Buffalo Pumps. Here you'll find the reasons for their easy maintenance and their suitability for long service. "Buffalo" Full Ball Bearing Pumps are available in a wide variety of alloys. For lowest cost in pumping your special liquids, write for BULLETIN 982 and let the specifications tell the story.





"Buffalo" PUMPS

BUFFALO PUMPS INC.

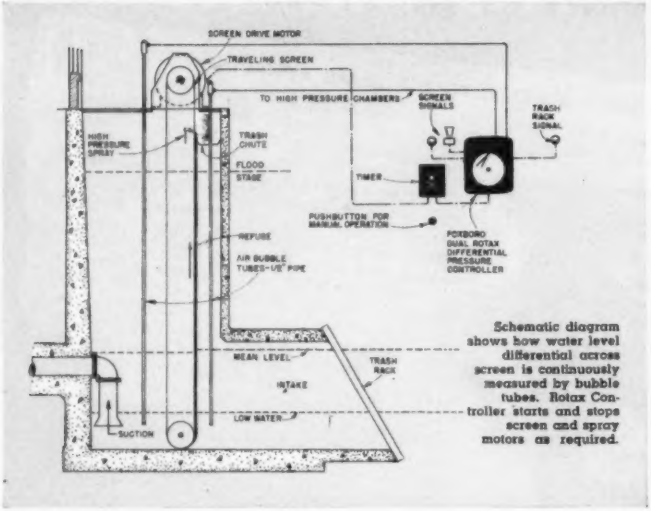
488 BROADWAY BUFFALO, NEW YORK

Canada Pumps Ltd., Kitchener, Ont.

Branch Offices in all Principal Cities

A BETTER CENTRIFUGAL PUMP FOR EVERY LIQUID

Make traveling intake screens positively "Plug-Proof"



Schematic diagram shows how water level differential across screen is continuously measured by bubble tubes. Rotax Controller starts and stops screen and spray motors as required.

...with Foxboro liquid level type screen control

Make sure your intake suction well can't go dry when excessive refuse suddenly piles up on the traveling intake screen!

The Foxboro Traveling Screen Control System automatically starts the screen-rotating motor and the cleansing spray whenever refuse accumulation causes the water level difference between opposite sides of the screen to exceed a certain preset value. Quickly, it purges the screen of refuse and restores the intake level to normal —or sounds an alarm indicating that the cleaning mechanism is unable to cope with the difficulty. What's more, this action takes place only when the screen actually becomes clogged . . . no waste of power or unnecessary wear on mechanism through needless periodic operation.

The Foxboro Traveling Screen Control System is easy to install, inexpensive to operate, and pays big dividends in better intake operation, less maintenance and greater peace of mind. Write for complete information. **The Foxboro Company, 683 Neponset Avenue, Foxboro, Mass., U.S.A.**

ROTAX Liquid Level Controller. The heart of the system, translates level differential into operation of motors. In addition, it can operate warning horn or light in case of unusually severe fouling. Circular or rectangular case models.

FOXBORO INSTRUMENTATION

is assigned to newly-created post of general manager of the laboratory. All three men will continue to have their headquarters in Schenectady. In the small and medium motor divisions, Francis J Boucher becomes manager of manufacturing; C B House Jr and Lee J Mohler, sales managers, respectively, of ac motor section and dc motor and generator section, Lynn (Mass.) motor sales div; and D S MacDonald, sales manager, gear motor section of gear motor and packaged drive div. In the Apparatus Dept, John W Belanger and Nicholas M DuChemin are named general managers of large apparatus divisions and small apparatus divisons, respectively. Both in their new capacities will be responsible to Henry V Erben, G-E vice-president.

In addition, **GE** also reports that Robert L Gibson is now general manager of Chemical Dept with headquarters in Pittsfield, Mass. Frederick G Weigand is made sales manager of alkyd resin products. Insulation & Wires, Inc, 3435 Chouteau Ave, St. Louis, Mo., is appointed an authorized distributor for G-E insulating materials. Everett S Lee succeeds Edward C Sanders as editor of *General Electric Review*, monthly engineering magazine published by the company. Sanders retired recently from the company after serving since 1926 as executive editor of the publication.

Carl J Meister has been elected vice-president and director of sales of **Atlas Chain & Mfg Co.** He will continue to make his headquarters at the main plant in Philadelphia.

Allegheny Ludlum Steel Corp announces a series of promotions in its sales dept as follows: Dr R A Lincoln replaces William B Pierce as manager of sales development and engineering service dept. Pierce is now technical director of the company. C R Mitchell is made manager of stainless strip sales. R S Robinson is named manager of carbon steel sales. Frank F Young becomes assistant manager of Pittsburgh, Pa., district sales office.

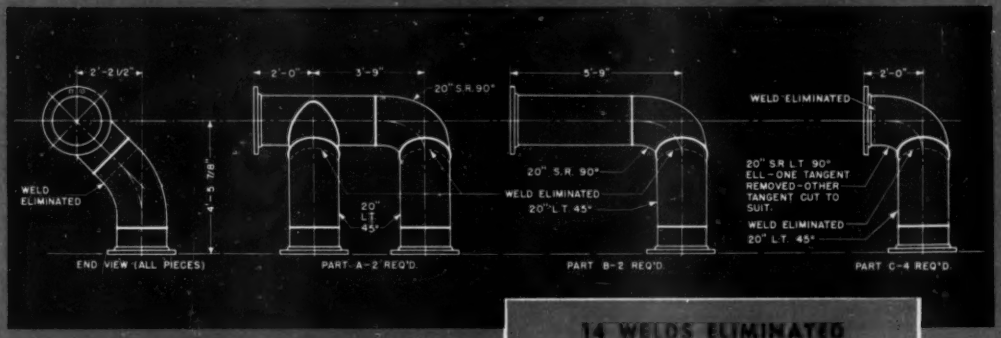
Berchem Co, 50 Church St, New York City pump specialists and sales representatives, have added **Faber Engrg Corp** to their list of representations. Simultaneously, they are discontinuing representation of Domestic Engine & Pump Co.

Burndy Engrg Co, New York, has designated David H Harris assistant advertising and sales promotion manager.

An office has been established in Dallas, Texas, by **Burgess-Manning Co.** R L Leadbetter, vice-president, will head the operation with assistance from S G Paddock as manager of sales, and A P Gallagher as engineering assistant. C P Certik has taken over as manager of Libertyville and Ashippun, Ill., activities.

Borg-Warner Corp announces election of Harold G Ingersoll as vice-president. He will retain the presidency of the firm's Ingersoll-Steel Div at Newcastle, Ind. I G Porter is elected treasurer. Paul J Larsen assumes duties of assistant to Roy C Ingersoll, president. Dr Maurice Nelles becomes

12% COST REDUCTION... *in these piping subassemblies*



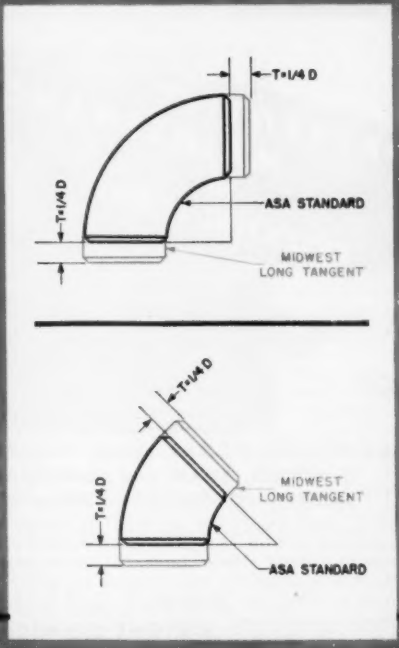
14 WELDS ELIMINATED
9'-8" OF 20" PIPE SAVED

with MIDWEST "LONG TANGENT" ELBOWS

Here is a concrete example of the extra cash value of Midwest "Long Tangent" Elbows. They saved 12% of the cost of this piping.

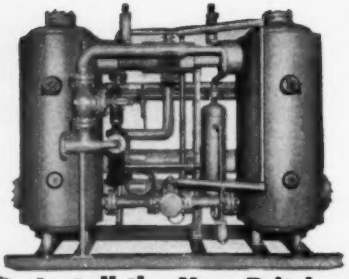
Each of the subassemblies shown above, if made of ASA elbows, would have required an extra nipple with an extra weld at the dotted line. With the Midwest Long Tangents, both the nipples and the welds were eliminated. Reduced material and labor costs made this substantial saving.

Other advantages of Midwest "Long Tangent" Elbows: pipe and fitting lined up more quickly and accurately, weld is removed from point of maximum bending stress, can be sleeved, slip-on welding flanges are more easily used, and they cost no more than standard elbows usually furnished. Ask for Catalog 48.



MIDWEST WELDING FITTINGS
Improve Piping Designs and Reduce Costs

MIDWEST PIPING & SUPPLY COMPANY, INC.
Main Office: 1450 South Second Street, St. Louis 4, Mo.
Plants: St. Louis, Passaic, Los Angeles and Boston • Sales Offices: New York 7—30 Church St. • Chicago 3—79 West Monroe St. Los Angeles 23—320 Anderson St. • Houston 2—1213 Capitol Ave. • Tulsa 3—224 Wright Bldg. • Boston 27—486 First St.



Install the New Pritchard
HYDRYER*...
...for Dependable Dehydration of Air and other Gases

Unexcelled for efficiency in drying air for instrument and process controls. Pritchard HYDRYERS are standard packaged units designed to reduce dew points of compressed air and other gases to minus (–) 40° F. Only service connections are required. Specially designed HYDRYER* units can be built to your requirements.

Write for FREE Bulletin No. 16.0.080 *Registered Trade Name

EQUIPMENT DIVISION
J.F. Pritchard & Co.
Dept. No. 99 908 Grand Ave., Kansas City 6, Mo.

District Offices:
HOUSTON • ST. LOUIS • CHICAGO • PITTSBURGH • TULSA • NEW YORK
Other Representatives in Principal Cities from Coast to Coast.

CONTROL SCALE AND CORROSION
in BOILERS, STEAM and CONDENSATE LINES, WATER JACKETS, CONDENSERS — Wherever Water Is Used

Now, more than ever before, it is necessary to increase the efficiency and life of equipment by maintaining scale-and-corrosion-free water-side surfaces. Let experienced Wright Chemical Engineers check the requirements for water-conditioning chemicals to solve your problems.

Wright CHEMICALS

WRIGHT CHEMICAL CORPORATION
Specializing in Water Conditioning
GENERAL OFFICE AND LABORATORY
617 West Lake Street, Chicago 6, Illinois
OFFICES IN PRINCIPAL CITIES
Sole Distributor of Nelson Chemical Proportioning Pumps

director of engineering development section in Bellwood, Ill. Thur Schmidt is made assistant to the president, Ingersoll Products Div, and will handle product development operations.

John C Koch has been named vice-president in charge of sales of **Conoflow Corp,** Philadelphia, Pa.

Charles G Cooper, manager of **Cooper-Bessemer's** Washington office, has been elected a vice-president. Walter H Kraemer has been assigned to the firm's field sales and service office in San Francisco, Calif.

Barry Corp, Watertown, Mass., has established a new department to assist in the solution of problems in shock and vibration isolation. Sheldon E Young has been promoted to manager of field engineering service.

George A Seaver joins **Howe Scale Co** as manager of its New York City branch. William H Leland becomes manager of Newark, N. J., branch. Also, new branch offices are now open in Denver, Colo., and Houston, Texas. The Denver office is at 2524 Walnut St and is managed by Daniel O Ferris. The Houston office is at 2215 McKinney Ave and is managed by Henry K Leonard.

Caterpillar Tractor Co announces creation of an additional sales division to be known as Plains div, made up of territory formerly under the Central div which will take over part of the Eastern div. Kenneth F Ames becomes sales manager, Plains div, with Lee Morgan and Gordon Fowler serving as assistant sales managers. E A Tiarks is now sales manager, Western div, and W F Jordan, assistant sales manager, Eastern div. Engine sales dept, managed by H W Smith, will now operate as the industrial div of general sales dept under the general administration of H H Howard, director of sales. Smith will continue as manager of the division.

Election of W W Warner as vice-president in charge of engineering of **Davey Compressor Co,** Kent, Ohio, has been reported.

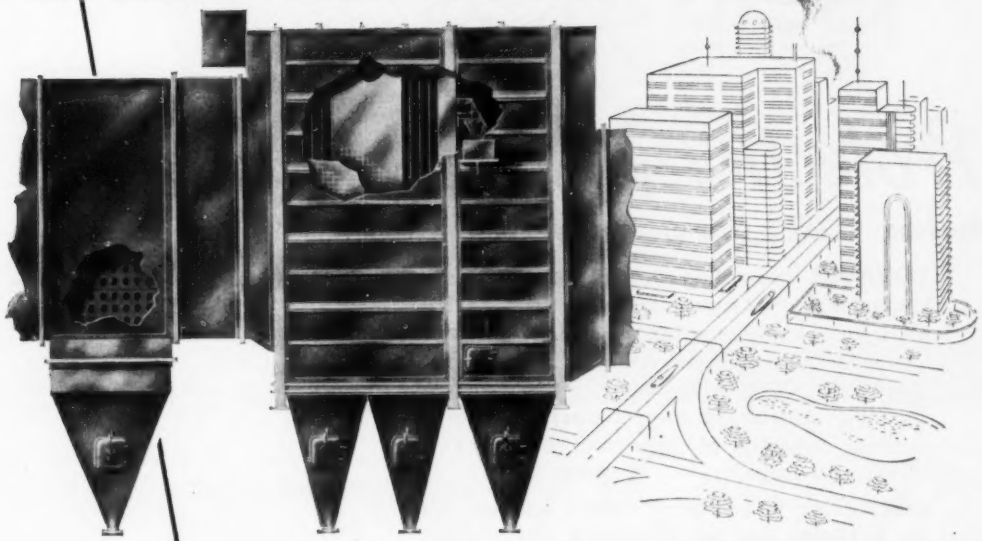
General Controls Co names D S Sterner manager of Refrigeration Controls Div, with offices in Chicago. Richard H Weber will manage the new factory branch office at 1035 N Pennsylvania St, Indianapolis 5, Ind.

Personnel appointments at the government synthetic rubber plant in Institute, W. Va., operated by **B F Goodrich Chemical Co,** are as follows: Tom B Nantz is named plant manager; Walter E Brodine, plant engineer; Sigmund S Michels, technical manager; and Anton Vittone, production manager.

Circle Seal Check Valves, manufactured by James-Pond-Clark, are now available from stock of the following distributors: Norman Engrg Co, 2035 W Charleston, Chicago, covering northern Illinois, southern Wisconsin, northeast Indiana and east Iowa; Nielson Hydraulic Equip, Inc, 298

engineered for the *Future*

THE AEROTEC SERIES COLLECTOR



Your dust collection equipment, a major investment, merits a thorough survey of the present trend toward more stringent dust ordinances.

To plan for the future, a collector should meet today's collection requirements, with provisions made for increasing the efficiency when dust ordinances become more stringent. It is well known that a mechanical collector is economical to operate. Such a collector therefore, that will meet present dust ordinance requirements and serve later as the primary to an electrical secondary, seems the logical choice.

The Aerotec Series Collector provides just this service. The primary, a highly efficient Aerotec Mechanical composed of multiple small diameter tubes, will meet most stringent dust ordinances in effect today. Should collection requirements be increased, the secondary, an Aerotec "Pocket-Type" Electrical Precipitator, is easily added to provide the finest in dust collection efficiency.

The Thermix Corporation, Project and Sales Engineers for the Aerotec Corporation, welcomes the opportunity to prove the sound engineering behind this arrangement . . . a combination engineered for the future.

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Steam + CORAVOL = Protection (FROM CORROSION)

(The Original* AMINE PROCESS)

Because CORAVOL Circulates to Control Corrosion

CORAVOL circulating throughout your steam system protects it from corrosive attack. **CORAVOL** saves costly pipe repairs and replacements—maintenance labor—hours and days of shutdown loss. **CORAVOL** cleans out clogging rust deposits, improving heat transfer, restoring original capacity of lines and efficiency of valves and traps.

CORAVOL, the original* amine process, has the flexibility that lets it conform to each individual need. The **CORAVOL** you will use is formulated to do the best protective job under your own plant conditions.

CORAVOL IS PART OF A COMPLETE TECHNICAL SERVICE which provides special formulas of chemical treatment for: boiler feed water . . . hot water supply . . . refrigerating brine . . . cooling and condenser water . . . rapid scale removal . . . coagulation . . . algae control . . . fuel oil supply . . . soot removal.

*The use of **CORAVOL** in steam systems is covered by U. S. Patent No. 2053024. The Western Chemical Co., owner of this patent, grants licenses under which volatile AMINES purchased from other sources may be used in steam systems upon payment of royalty to Western Chemical Co.

Chemical Water Treatment

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Lafayette St, New York City, for northern New Jersey, eastern New York, Connecticut and Berkshire, Mass., territory; Scott Equip & Engrg Co, 1316 Lorain Ave, Dayton, Ohio, will cover southern half of Ohio.

Industrial Air & Hydraulic Equip Co, 13306 Kercheval Ave, Detroit, has been chosen by **Hanna Engrg Works** as its exclusive sales representative in Michigan (all east of Lake Michigan).

Johnson Corp announces a change in representation on the West Coast. Guy L Warden & Sons, formerly district representative for Johnson in lower California, will now cover the entire state, as well as counties of Curry, Josephine and Jackson in Oregon. In addition to offices at 209 W 12th St, Los Angeles, Warden now has offices at 5200 E 12th St, Oakland, also.

Otto Hecht has been named production manager of **Laminated Shim Co,** Glenbrook, Conn.

W R Persons has been elected vice-president in charge of sales of **Lincoln Electric Co,** Cleveland, Ohio.

Paul M Arnall succeeds Frank P Rhame who resigned as president of **Lunkenheimer Co,** Cincinnati, Ohio. Rhame will continue as a director and in an advisory and consulting capacity with the firm.

William Ensign has been promoted to assistant sales manager of **Marsh Heating Equip Co,** sales affiliate of Jas P Marsh Corp, Skokie, Ill.

William L Hunter assumes position of vice-president and general manager of **Northern Equip Div,** Continental Foundry & Machine Co, Erie, Pa.

Purolator Products, Inc, Rahway, N. J., has made James B Lightburn assistant to Carlos D Kelly, vice-president in charge of sales.

C S Beattie is elected executive vice-president and general manager, and R E Anderson is named senior vice-president of **Delta-Star Electric Co,** Chicago, a division of H K Porter Co.

Lester E Robb joins **Rockbestos Products Corp,** New Haven, Conn., as chemical engineer.

Trane Co, La Crosse, Wis., announces election of R E Lucey and H C Rooks as vice-presidents. E A Cline becomes sales manager, reporting to Thomas Hancock, vice-president in charge of sales. R E Haskins succeeds Cline as manager of convector-radiator sales.

Sintercast Corp of America appoints Robert L Pettibone to position of chief metallurgical engineer.

Rockwell Mfg Co announces acquisition of both Pittsburgh Valve & Fittings Div of Pitcairn Corp, and Pittsburgh Valve & Fittings Corp, a subsidiary of Pitcairn. Manufacturing facilities and principal offices of Pittsburgh Valve are in Barberton,

ChromeLock

. . . AN IDEAL, EASY-TO-WRAP COVERING FOR COLD WATER PIPES

One of many typical installations in the world's largest hotel—The Stevens, Chicago, Illinois

Chrome Lock—Ideal covering for pipes subject to condensation. It eliminates sweating, dripping, completely. In appearance it makes a very compact wrap with no bulk. To apply merely spiral wrap with a minimum overlap, no bonding necessary except at the start and finish of wrap. You can install and remove with ease. Chrome Lock may be reclaimed when dismantling is necessary.

Chrome Lock imparts no odors and no clean-up is required. It is excellent also as a gasketing material.

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Cincinnati, Ohio	Indianapolis, Ind.	Philadelphia, Pa.	St. Louis, Mo.
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Cleveland, Ohio	Milwaukee, Wis.		Wilmington, Cal.

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FIBROUS AND METALLIC PACKINGS FOR EVERY INDUSTRIAL PURPOSE

Save Time with DART Unions

You'll

This True Ball Joint Makes the Difference

SAVE IN INSTALLATION!

The spherically-ground, true ball joint of a Dart easily gives a snug, drop-tight fit. There's no need for fussing — no need for excessive wrenching — no lost time in installation.

SAVE IN MAINTENANCE!

This same design feature makes uncoupling fast and easy, too. And you'll find the seats clean and unmarred — ready for re-installation without any time loss.

What's more, Darts save in other ways. The bronze-to-bronze seats have highest resistance to pitting and corrosion; body and nut of high-test, air-refined malleable iron are practically indestructible. Thus a Dart lasts years longer — eliminates the replacement costs of inferior unions.

DART UNION COMPANY

Providence 5, Rhode Island

The Fairbanks Co. — Distributors

Boston New York Pittsburgh

DART UNIONS

Ohio. The plant will be operated as one of Rockwell's meter and valve divisions under direction of L A Dixon, vice-president. R G Caouette will become general manager of the Barberton property. J A Strachan, general manager of sales of Pittsburgh Valve will continue in that capacity as will all district managers.

A G Hendrickson is now associated with **A O Smith Corp,** Milwaukee, Wis., as welding equipment sales manager. He will function under welding division sales manager, L F Vonier.

Taylor Dynamometer & Machine Co has moved into new quarters located at 528 W Highland Ave, Milwaukee, Wis.

E C Iverson assumes position of chief engineer for **Towmotor Corp,** Cleveland, Ohio.

David E Feinberg has been appointed defense contract co-ordinator of **U. S. Air Conditioning Corp,** Minneapolis, Minn., in addition to his duties as manager of refrigeration div. Burton S Fox has been named assistant to Feinberg in his newly created post.

Wheelco Instruments Co selects Ansell & Goda, with new office at 3432 Connecticut Ave, N W, Washington, D. C., as its district agency for the territory of Virginia, part of Maryland, and the District of Columbia. Former agent in this territory, Phipps & Bird Co, will continue to serve as an authorized resale agency of Wheelco.

Raymond C Gaugler is elected president of **American Cyanamid Co.** He succeeds the late William B Bell, who died suddenly on Dec 20, 1950. In addition, Donald S Barnes becomes sales representative for Cincinnati territory of pigment dept, Calco Chemical Div of the firm. Richard L Newman joins technical field service division of above department.

Noel B Hinson, vice-president and executive engineer of **Southern California Edison Co,** has retired after 44 years of continuous service. He will retain his post as chairman of Pacific Southwest Power Interchange Committee.

Alfred Paul succeeds Allie Staples, retired, as chief of the Biddeford steam plant of **Central Maine Power Co.**

Stuart P Gillespie has been appointed research engineer of **Connecticut Light & Power Co,** with headquarters at Waterbury. He has replaced E J Amberg who retired on Jan 1.

E G Nielsen succeeds L R Douglass as assistant director of the **Bureau of Reclamation's** Region 3.

Leslie Cleminson has been chosen to replace Lawrence Killam, retired, as general manager of **B. C. Pulp & Paper Co,** which has its administrative offices at Vancouver, B. C., Canada. Killam will continue as a member of the board of directors.

Bosworth E Monck succeeds Ronimund Bissing, resigned, as executive vice-presi-

Good workmen + good tools + GOOD PIPE = GOOD JOB!

7 POINTS OF UNIFORM GOODNESS IN YOUNGSTOWN STEEL PIPE

- uniform ductility
- uniform lengths
- uniform threading
- uniform weldability
- uniform wall thickness and size
- uniform strength and toughness
- uniform roundness and straightness

ON the job or in the shop, you like to work with Youngstown pipe. Cutting is clean, fast and easy because Youngstown pipe is uniformly round and soft--true to size, even in grain structure, free of inclusions and hard spots. The name Youngstown, rolled into every length, means GOOD PIPE.

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Youngstown STEEL PIPE

THE YOUNGSTOWN SHEET AND TUBE COMPANY

Manufacturers of Carbon, Alloy and Yoloy Steel

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PIPE AND TUBULAR PRODUCTS - WIRE - ELECTROLYTIC TIN PLATE - COKE TIN PLATE - HOT AND COLD FINISHED CARBON AND ALLOY BARS - RODS - SHEETS - PLATES - CONDUIT - RAILROAD TRACK SPIKES.

★ NEW Sier-Bath SCREW PUMP
External Gear and Bearing Bracket Type
FOR NON-LUBRICATING LIQUIDS, SEMI-LIQUIDS

Capacities: 1-700 GPM
Discharge: 1000 PSI for viscous liquids
300 PSI for water

★ Greater Dependability
★ Lower Maintenance Costs
★ Longer Life

★ **New Single-Point Alignment**—eliminates bearing strain and rotor misalignment due to change of position of pump elements. Housings for external timing gears and bearings bolted directly to pump body—thus move **with** pump body if it is displaced during installation, or if it expands when handling hot liquids.

★ **New "Dual-controlled" Rotors**—for less wear on bearings and timing gears. **Axial** control by heavy-duty thrust bearings—**radial** control by precision cut timing gears **and** heavy-duty roller bearings.

★ **New Speed in Servicing**—gear housing center line supported, doweled for accurate alignment. All parts automatically positioned by shoulders and locknuts.

PLUS These Regular Sier-Bath Advantages:

No metallic contact between rotors—sustains high volumetric efficiency.

Only suction pressure on stuffing boxes—reduces packing maintenance.

Less strain on valves and piping—minimum cavitation because pump reduces velocity change. Eliminates hammer, vibration.

Direct-connected up to 1800 RPM, Self-priming, Pulseless Discharge.

Available in horizontal or vertical construction, corrosion resistant alloys. Special bodies, stuffing boxes and bearings for high temperature applications. Sier-Bath "Gearex" Pumps for lower pressures and capacities.

WRITE FOR FURTHER INFORMATION
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Sier-Bath GEAR and PUMP CO., Inc.

Also Makers of Sier-Bath Precision Gears and Gear Couplings
Founded 1905 Member A.G.M.A.

dent of **ABOE, Inc,** New York, the American branch of Associated British Oil Engines, Ltd, London. Bissing remains with the company as a director.

W R Craig assumes duties of F H Ballou, retired, as chief engineer for **B. C. Sugar Refining Co, Ltd,** at Vancouver, B. C., Canada.

Benjamin F Cook, consulting engineer, announces change of address to 15 W 10th St, Kansas City, Mo.

J J Jaklitsch Jr has been made technical editor of *Mechanical Engineering*, official monthly magazine of **ASME.** Alfred F Bochenek has become news editor.

National Constructors Assn announces following elections: *President*—J F Pritchard, president, J F Pritchard & Co; *vice-president*—J J O'Donnell of Lummus Co; *secretary-treasurer*—C B Bronson.

OBITUARIES

Richard H Thomas, 87, founder of Hamilton-Thomas Corp, Hamilton, Ohio, died Dec 30, at Mercy Hospital in Hamilton.

John Avery, president of Roots-Connersville Blower Corp, Connersville, Ind., died Jan 13 of a heart attack.

Stanley L Schauss, 42, an associate professor of electrical engineering at Cornell University, died suddenly Jan 24 in Newark, N. J.

Patrick J Kiernan, stationary engineer for 27 years at the Rhode Island State Capitol building in Providence, died Jan 22. He had retired in May, 1950.

TECHNICAL BRIEFS

PANEL HEATING-RESEARCH PROGRESS, *by P B Gordon, Wolff & Munier, Inc.* The author explains why and how the ASHVE-panel heating-research program was set up and how it is functioning. He went on to reveal certain information resulting from the research program. For instance, the type of pipe material and idle tubes seems to have no appreciable effect in the performance of radiant heating panels. Insulation on the back side of the tubes in connection with heated plastered ceilings has very pronounced effect on down-side heat flow.

Cooling panels can be used even at temperatures of 70 and 80 F to (1) enhance thermal storage of building (2) directly intercept radiant energy such as that coming from electric light (3) cool a room and affect comfort relationship. Panel cooling at this time does not seem likely to take over the entire job of cooling a building. *No number. Papers not available. Illinois chapter meeting, American Soc of Heating and Ventilating Engineers.*

For more briefs, see page 136.

BOILER TUBE CO. OF AMERICA

Tube Stocks and Bending

BOILER TUBE CO. OF AMERICA
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(Pittsburgh District)
PITTSBURGH
CHICAGO
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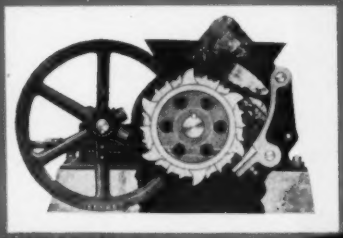
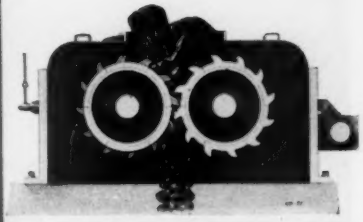


SINGLE ROLL



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CRUSHERS PULVERIZERS SHREDDERS

A type and size for reducing most materials to desired size in

- Chemical Plants
- Quarries and Cement Mills
- Pulp and Paper Mills
- Power Plants
- Industrial Plants
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LITERATURE ON REQUEST

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Complete Line of Material Handling, Processing and Mining Equipment

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Fig. 3169 single stage, open impeller centrifugal

Goulds *New Design*

gives carefree pumping efficiency for the long pull

The 3169 is one of the latest designs to come off Goulds drawing board. It takes every advantage of modern hydraulic design—and it is thoroughly tested and proven for economy and dependability.

With the 3169 you get tremendous versatility with high operating efficiency and relatively low power consumption.

REAL "JACK-OF-ALL-TRADES" ADAPTABILITY

This new pump will fit many applications—water service, irrigation, slurries, circulation, transfer, factory wastes, air conditioning service, plumbing, heating, and many others. If you face conversion, this adaptability is a double value.

TEN SIZES TO FIT YOUR NEEDS

Available in ten sizes for both motor and belt drives. Capacities up to 1080 G.P.M.—with heads to 290 ft. depending upon capacity.

For complete information phone or write Pump Headquarters, Seneca Falls, N. Y. Ask for Bulletin 720.4.

MEMBER

Goulds PUMPS INC. Seneca Falls New York

POWER NEWS

(Continued from page 140)

Charleston, N. C. Plans More Water

A few miles north of the city of Charleston, N. C. will be the site of the largest industrial water supply on either the East or West coasts if present plans go through to completion. It is estimated that over 2,500,000,000 gal of water would be provided, enough to supply more than 75 times the amount of water now used by the West Virginia Pulp and Paper Co, the city's largest single customer.

A dam would be constructed in Back River just before it enters Cooper River to prevent salt intrusion. A canal from the northern end of Back River would connect with Cooper River seven miles north of the point of maximum salt intrusion. Fresh water, then, would come from this canal into Back River from the discharge of the Pinopolis Reservoir of Santee Cooper. The industrial area on high ground between the Back and Cooper Rivers would benefit from this fresh-water supply.

Canada's Power Has Record Development

During 1950, 1,037,275 hp of new capacity went into operation in Canada, which is a record for that country. Total installed water-power plants in Canada is now 12,654,835 hp, about 23% of the total potential from these resources.

A large part of the 1950 increase is in Ontario and Quebec, major additions being the Ontario Hydro-Electric Commission's nearly completed Des Joachims plant on the Ottawa River and the Shawinigan Water and Power Company's addition to the La Trenche plant on the St. Maurice River. Power development extended all the way to the Northwest and Yukon Territories where a diesel-electric power plant at Fort Smith, N.W.T. was completed in October. Work was started on a 3000-hp hydro development on Mayo River, Y.T., to serve the silver-lead mines of the district.

Other new plants and additions are well-distributed across Canada. Hydroelectric developments and extensions that are under active construction total about 1,000,000 hp. Projects under preliminary construction or definitely planned are tentatively rated at 1,500,000 hp.

Because of an increase of about 8% in the demand for primary power during the year, there were also many activities in the field of power distribution. These include construction of new main transmission lines, substations and extension of secondary lines. New fuel-power electric plants, as well as extensions to existing stations, have also been completed or are under construction.

Engineers for the **Washington State Public Service Commission** recommend steam-electric generation, probably using fuel oil, as a supplement to the Pacific Northwest hydro power. At present, such plants could not compete with hydro power

Inverted bucket in-line trap. To 250 p.s.i. Sizes ½" to 1".
Open bucket trap. Semi-steel or cast steel. Sizes ½" to 3".
Inverted bucket trap. All stainless fitted. To 250 p.s.i. Sizes ½" to 2½".
Inverted bucket blast trap (thermal air by-pass). Sizes ½" to 1".
Ball float trap for draining air line or venting service. To 200 p.s.i.
Forged steel inverted bucket trap. To 1,800 p.s.i. Sizes ½" to 2".
HERE'S WHY YOU SHOULD BRING YOUR STEAM PROBLEMS TO
STRONG
1. Over 40 years' specialized engineering experience in all types of steam problems;
2. Completeness of the STRONG line gives you the added advantage of choosing exactly the right size and type of steam specialty to meet your individual need;
3. Acceptance of STRONG products as standard by outstanding engineering firms and large users;
4. Advanced engineering design to maintain leadership in the field.
Insist on genuine STRONG steam specialties and repair parts for reduced maintenance and increased production. A large staff of STRONG factory-trained field engineers is at your service. Bring your next steam problem to STRONG*.
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*Trade Mark Reg., U. S. Pat. Off.
Fabricated horizontal or vertical steel separator. Sizes ½" to 10".
Pilot operated pressure regulator for steam, air, gas. Sizes ½" to 4".
Trap for removing liquids from vacuum or lifting (pumping) service.
Direct operated reducing valve for steam, air, gas. Sizes ½" to 1½".
Black steel valve for continuous blowdown or throttling service.
Quiet closing strainer. Semi-steel and cast steel. Sizes ¼" to 4".

SPECIFY STRONG STEAM SPECIALTIES

ALNUM-METL Reg. Trade Mark

SEND FOR NEW STRONG CATALOG!

Complete, up-to-date specifications and prices on entire Strong line including steam and lifting traps, reducing valves, separators, strainers, continuous blowdown valves, and engine stops. Valuable tips on piping and trap sizing, etc. Write for Catalog 68-P today!

Discarding condensate because of OIL?

If you are throwing away valuable condensate rather than risk its return to the boiler because of oil contamination, filtration with Sorbo-Cel may be the answer to your problem.

Low in Cost

This specially processed diatomaceous silica powder provides a simple, economical method of removing emulsified oil from water and thereby obtaining an oil-free condensate for boiler feed or other use. Total cost ranges from only 1¢ to 3¢ per 1000 gallons of water filtered.

How it works

A small amount of Sorbo-Cel is simply mixed with the oil-contaminated water, which is then pumped through a pressure filter. Here the oil globules are removed by the specially treated Sorbo-Cel particles, and both are retained upon the filter screen. The filtered water alone passes through.

Does complete job

Sorbo-Cel does a complete job of oil removal. In addition, it removes other suspended matter such as rust, scale, clay and precipitates. And its action is so efficient that large volumes of water can be filtered in a relatively short time.

A bulletin that gives further facts about this low-cost way to remove oil from water is available on request. Just use the coupon below.

Johns-Manville SORBO-CEL

Johns-Manville
Box 290, New York 16, N. Y.
Send me free bulletin giving advantages of Sorbo-Cel filtration.

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Pow-3

and would require a subsidy. By 1965, however, it will become reasonable to project base-load fuel-burning plants as part of the power program. Steam-generated power is estimated to cost about 6 mills per kwhr including transmission expense and a 2% property tax, quite some above the present 2 mills charge from Grand Coulee and Bonneville.

COMING EVENTS

March 11-17—International Industrial Exposition, Coliseum, Houston, Texas. E G Lenzner, general manager, Industrial Exposition, 41 San Jacinto St, Houston 2, Texas.

March 13-16—National Assn of Corrosion Engineers, Conference and exhibition, Hotel Statler, New York. L B Donovan, chairman, Consolidated Edison Co, 4 Irving Place, New York, N. Y.

March 15-17—American Society of Tool Engineers, national meeting, Hotel New Yorker, New York. Mr Denham, 812 Book Bldg, Detroit 26, Mich.

March 21-22—Conference on Combustion of Industrial Fuels, Univ of Michigan, Ann Arbor, Mich. Institutes Dept, Extension Service, Univ of Michigan.

April 2-5—American Society of Mechanical Engineers. Spring meeting, Hotel Atlanta-Biltmore, Atlanta, Ga. O B Schier, ASME, 29 W 39 St, New York 18, N. Y.

April 2-6—Oil Heat Institute of America, 28th annual convention, Palmer House, Chicago, Ill. Mr Kaufman, secy, OHI, 6 E 39 St, New York 16, N. Y.

April 4-6—Midwest Power Conference, annual meeting, Sherman Hotel, Chicago, Ill. R A Budenholzer, director, Illinois Institute of Technology, Chicago 16, Ill.

April 16-18—American Society of Lubricating Engineers. Annual meeting, Bellevue-Stratford Hotel, Philadelphia, Pa. W F Leonard, secy, ASLE, 343 S Dearborn St, Chicago, Ill.

April 30-May 2—Refrigeration Equipment Manufacturers Assn, annual meeting, The Homestead, Hot Springs, Va. REMA, 1346 Connecticut Ave, Washington 6, D. C.

May 7-11—Greater New York Industrial Show, Technical Societies Council of New York, Inc, Armory, 34th St and Park Ave, New York. Orkin Management, 8 W 40th St, New York 8, N. Y.

National Conference of **Business Paper Editors** has appointed the following committee of editors to cooperate with Office of Defense Mobilization: J G Lyne, chief editor, *Railway Age*, and president Simmons-Boardman Publishing Co; Godfrey Lebhar, chief editor, *Chain Store Age*; Dr. S D Kirkpatrick, editorial director, *Chemical Engineering*; Eldridge Peterson, chief editor, *Printer's Ink*; P W Swain, chief editor, *Power* and *Operating Engineer*;

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BELMONT SHEET PACKINGS
Wherever flange and parallel surface joints must be connected for long trouble-free service—always select Belmont, the Better Sealing . . . longer lasting Sheet Packings.
Long experience has made sheet packing manufacture a SPECIALTY with Belmont, that's why Belmont Sheet Packings are selected for every temperature...every pressure...every conceivable type of service.
You can get standard Belmont Sheet Packings—made of compressed asbestos, asbestos metallic, red rubber, cloth inserted, vegetable fibre and a wide range of other constructions. However, whether you require standard or special sheet packing, remember—you always get better sealing . . . longer life with Belmont.
CUT YOUR OWN GASKETS
WITH BELMONT GASKET CUTTER
A portable tool for cutting 1¼" dia. to 19" dia. circular gaskets from all kinds of soft sheet packings. Rigid and simple to operate. Larger sizes only require cutter bar replacement.
THE BELMONT PACKING AND RUBBER CO.
Butler and Sepviva Streets
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There's a Belmont Packing for every service
Rings - Sprints - Coils - Reels
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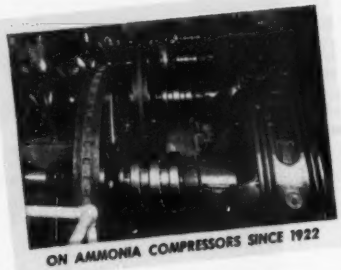
FAST'S COUPLINGS cost you less to own and operate

ON BILLET MILL SINCE 1923

ON GAS BLOWER SINCE 1920



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Clifford B McManus, president of Georgia Power Co, was named to the long-vacant post of Administrator of the **Defense Power Administration** of the Dept of Interior by Interior Secy Oscar L Chapman.

U. S. Air Force has placed a $20,000,000 order for electrical equipment with the **Westinghouse Electric Corp** for a new wind tunnel to test full-size jet engines, guided missiles and wing sections and fuselages of aircraft.

A new monthly magazine, **Book Previews**, has been announced. It will give factual information about books not yet published but due from the presses within six weeks from magazine publication date. Since there are about 10,000 books published each year in all categories a breakdown into about 55 categories such as the magazine furnishes helps in selecting and choosing books.. The venture is handled by Book Previews, Inc, 11 E 48th St, New York 17, N. Y.

Iceland is going to have her first underground power plant. A site has been selected on the lower reaches of the river Sog. The plant is expected to cost 63 million kroner, the equivalent of 9 million dollars. Machinery will be imported at a cost of 3-3½ million dollars. But this will only be possible if Marshall Plan aid is available. First stage of the scheme calls for harnessing about 47,000 hp, and the second stage, a further 23,000 hp. Plant will be a hydroelectric installation.

Two Former Power Contributors Pass On

Only recently POWER has heard of the deaths of two of its long-time contributors and personal friends, C Brooks Hudson, former chief engineer of the Plymouth Cordage Works in Plymouth, Mass.. and A J German, long time power-plant chief engineer of the Scovill Mfg Co, Waterbury, Conn.

German, recently retired, died in Walnut Creek, Calif., back on Nov 25. He was a self-made mechanical engineer who prepared himself for his work through home study and correspondence school courses.

Hudson, who died suddenly on Oct 29, had grown up in the power plant. He had held his first-class engineer's license in the State of Massachusetts since 1912 and had been chief for 30 years at the Plymouth Cordage Works.

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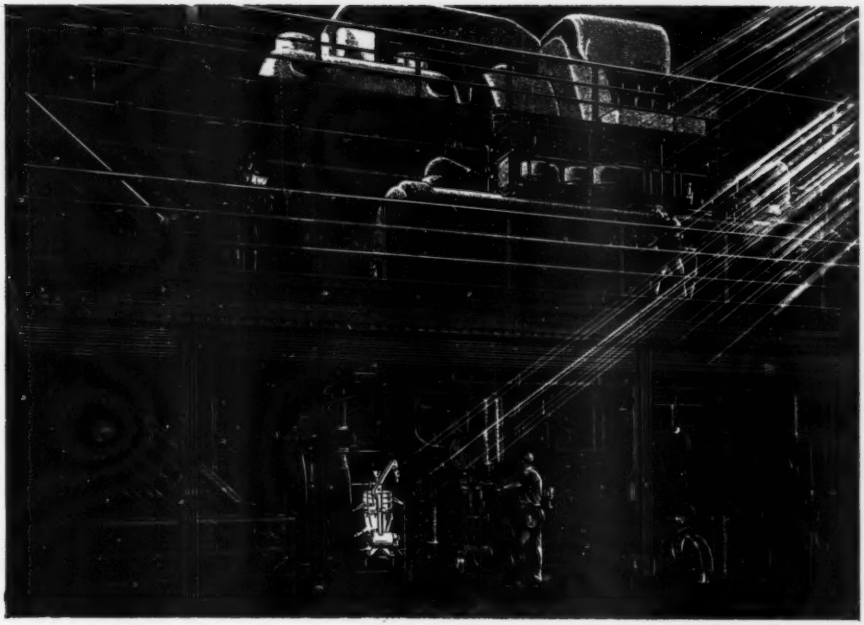

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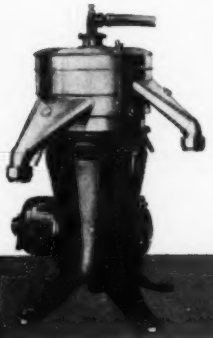

The installation pictured above is in one of the great central stations of the East. It is described in the De Laval Centrifugal Review, Volume 16, No. 1. Sent free on request. ***Write for a copy.***

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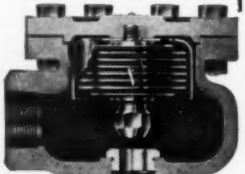

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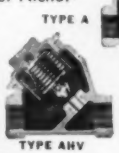

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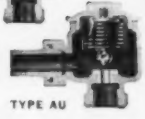

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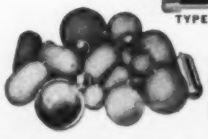

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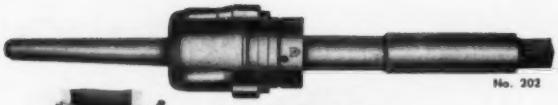

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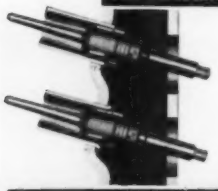

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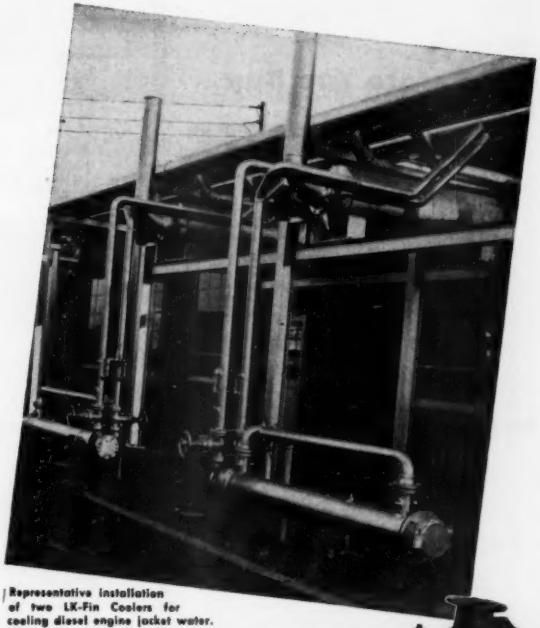
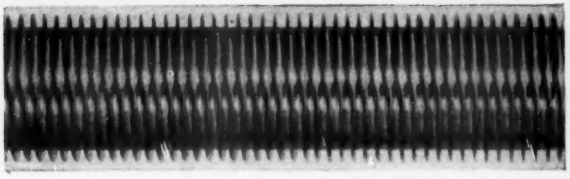


Representative installation of two LK-Fin Coolers for cooling diesel engine jacket water.

Single-pass LK-Fin Cooler viewed from stationary head end



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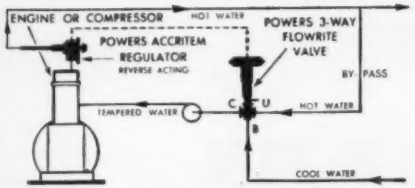

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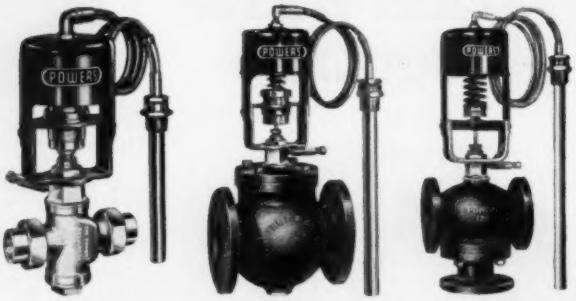

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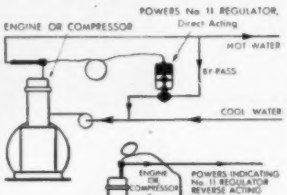

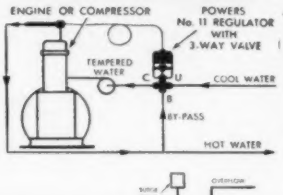

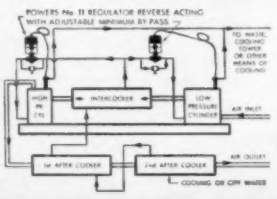
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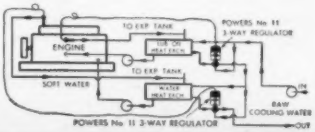

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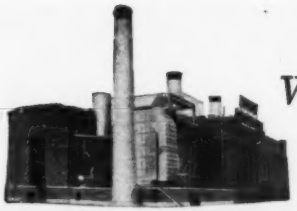

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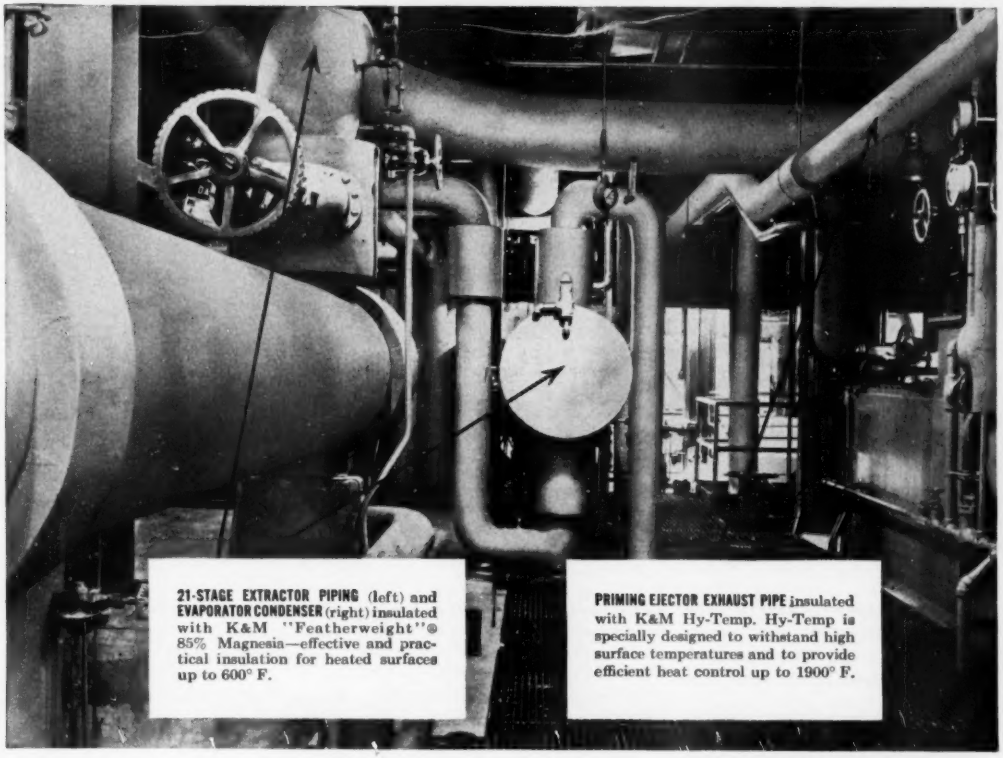

21-STAGE EXTRACTOR PIPING (left) and **EVAPORATOR CONDENSER** (right) insulated with K&M "Featherweight"® 85% Magnesia—effective and practical insulation for heated surfaces up to 600° F.

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In power stations, oil refineries, chemical plants, factories, steamships, hospitals—in fact, wherever exacting steam control is a must—you'll find K&M "Featherweight" 85% Magnesia and K&M Hy-Temp Insulations. These two K&M products give you highly efficient, cost-cutting insulation in every service temperature range. And, for especially difficult heat control situations, the advantages of both are combined in K&M Hy-Temp Combination Insulation.

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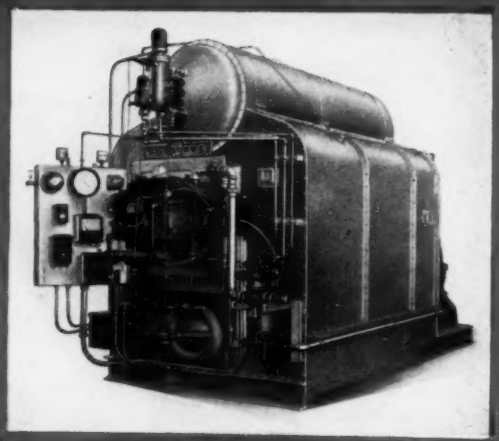
In Canada—ATLAS ASBESTOS CO., LTD., MONTREAL, TORONTO, WINNIPEG and VANCOUVER

Here's What You Get...

for your KEYSTONE *dollar*

The Erie City Keystone Steam Generator combines a low headroom, 2-drum water tube boiler; insulated steel casing; automatic burner for either oil or gas or both, interchangeably; control panel with all instruments and safety controls wired and piped at the factory; induced draft equipments—all mounted on a common base and shipped as complete units in sizes to 800 h.p.



150 hp. Erie City Keystone Steam Generator with Combination Oil or Gas Burner.

Compact Design—The Keystone packs large steam capacity in small cubage, because of its unique furnace, contained within a low-head 2-drum water tube boiler.

Conservatively Rated—The Keystone offers unusually large heating surface per developed horsepower. Ratings are based on 5 square feet per developed horsepower—accepted practice in water tube boiler design.

Fast Steamer—The Keystone is highly responsive to changing load demands, for hot gases travel 3 lengths of the furnace, contacting 5 bare metal heat absorbing zones. Big boiler performance in small space.

Centralized Control—All specified instruments and controls, factory assembled, and mounted on a central instrument panel. All electrical connections to terminal blocks eliminate inter-connecting field wiring.

Automatic Burner—The Keystone is equipped with fully automatic burner for gas, oil or for both interchangeably.

Insulated Steel Casing accurately fitted to reduce radiation losses and air infiltration—removable panel type—all tubes accessible.

Combustion Control—interlocked electrical controls, steam pressure actuated for smooth adjustment of fuel, primary and secondary air supply to obtain most efficient high and low flame position.

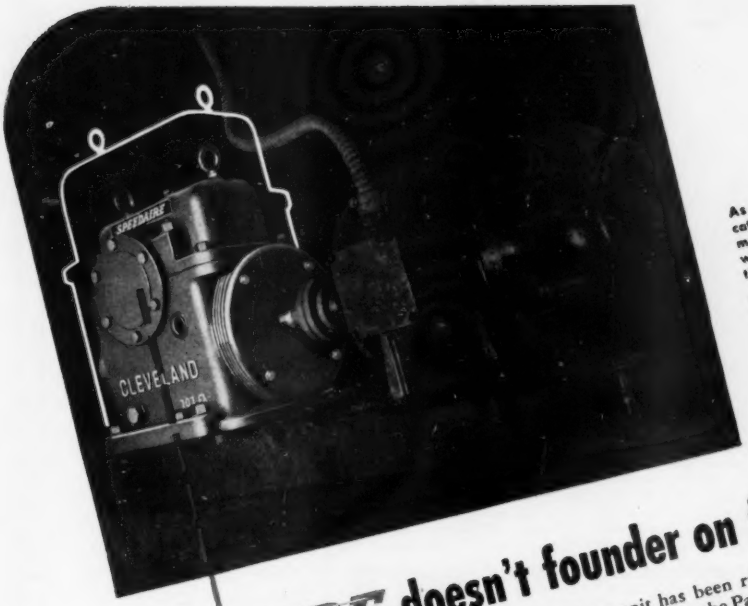
Induced Draft equipment is of low speed, conoidal type with automatic damper control on panel.

Safety Controls include automatic cut-offs for high pressure, low water, flame failure, induced draft failure and fire switch.

Easy to install—easy to maintain—Keystone requires no special foundation or stack—just set in place and hook up service connections. Wind box is hinged for easy furnace inspection, hinged burner swings out for inspection—removable side panels give access to any tubes—manholes provide access to drums and tubes.

WRITE FOR BULLETIN 28-18 TODAY:

ERIE CITY IRON WORKS *1403 East Ave.* **ERIE, PA.**



As the white outline indicates, a standard unit of much greater frame size would be required to do the work of Speedaire.

Photograph by courtesy of the Packard Motor Car Company.

SPEEDAIRE doesn't founder on foundry sand

FOR well over a year, this Speedaire unit has been running continually, driving a spiral conveyor in the Packard Production Foundry at Detroit. As the photograph reveals, operating conditions are quite severe, both motor and reducer being subjected constantly to sand and grit.

Speedaire was selected for this service because of the three-way saving it offered, compared to the conventional worm gear speed reducer. Speedaire is 23½% lighter in weight, takes 38% less space and costs 12½% less money than the standard unit required to do the job.

Speedaire is Cleveland's fan-cooled worm-gear speed reducer. Because it is fan-cooled, Speedaire will do more work—will deliver up to *double the horsepower* of standard worm units of equal frame size, at usual motor speeds. It can be installed economically on many applications where other types have been used heretofore—giving you the advantage of a compact right-angle drive. Speedaire gives the same long, trouble-free service characteristic of all Clevelands.

For full description, send for Catalog 300. The Cleveland Worm & Gear Co., 3262 East 80th St., Cleveland 4, O.

Affiliate: The Farval Corporation, Centralized Systems of Lubrication. In Canada: Peacock Brothers, Limited.

CLEVELAND
Worm Gear
Speed Reducers

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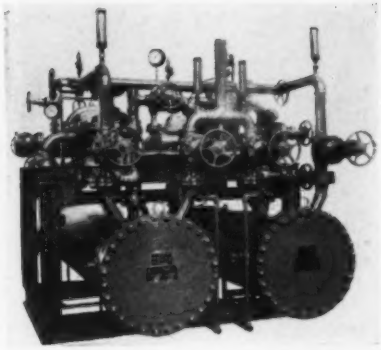

The compact, high-pressure unit illustrated consists of two, Turbine-driven Rotary Pumps and two, Shell-and-tube-type Oil Heaters mounted on a single frame.

FOR almost a half century, Lockett has been supplying, to fit individual needs, efficient standard and custom-built, Fuel Oil Pumping and Heating Sets, for mechanical and steam atomizing oil burners. Combinations of various types of pumps are available: Either two Turbine-driven Pumps; one Electric-driven and one Turbine-driven Rotary Pump; two Electric-driven Rotary Pumps; two Worthington Duplex Steam Pumps; or one Duplex Steam Pump and one Electric-driven Pump. Each pump-and-heater is suitable for the full rated capacity of the unit; the second pump and heater are spares. Lockett supplies everything, complete. Inquiries are invited. *Descriptive bulletins sent on request.*

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Polluting the Air
With

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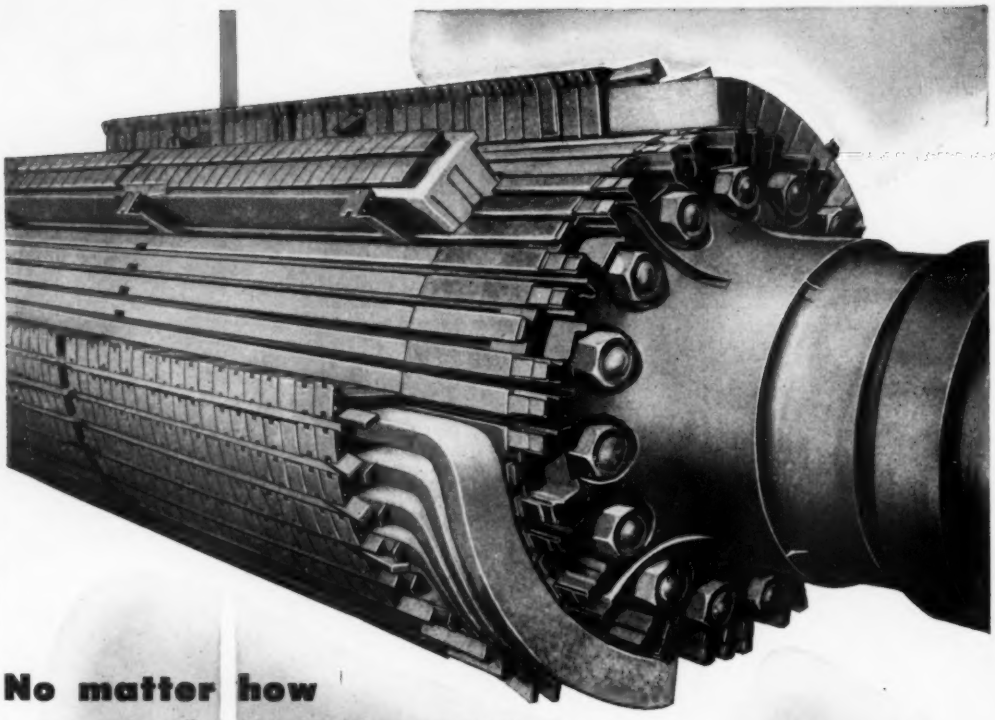

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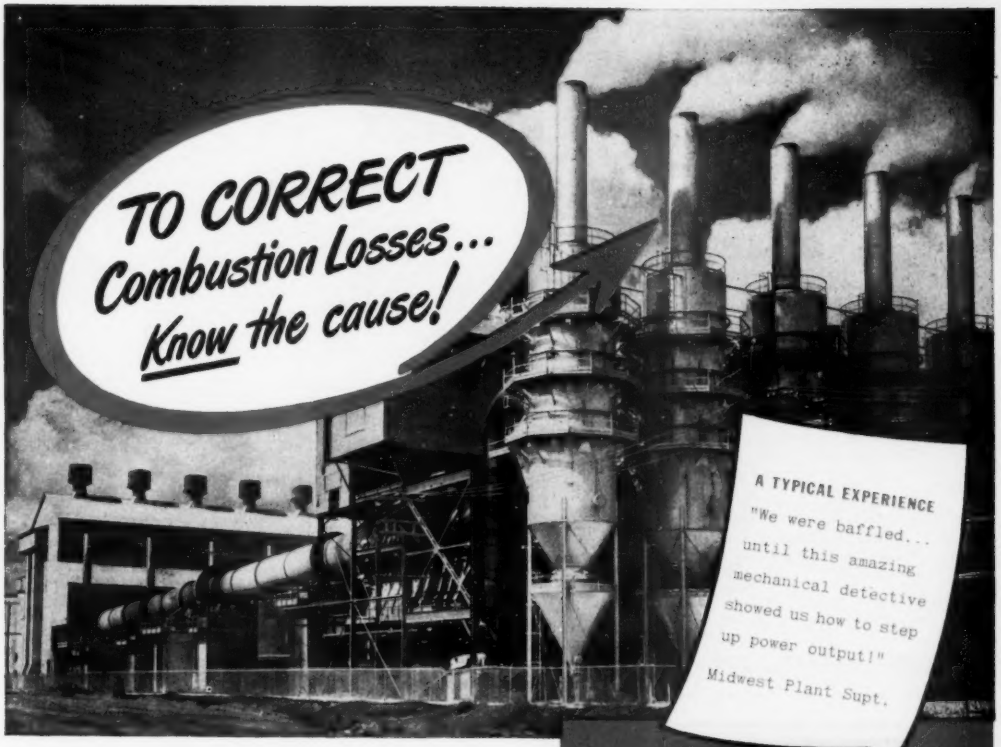
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Know the cause!
A TYPICAL EXPERIENCE
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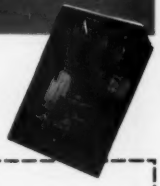

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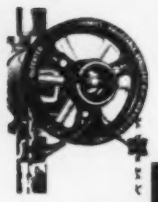

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● Range of 10 adjustable sizes takes care of all valve makes and types; fits valve wheel diameters from 2 to 30 inches.

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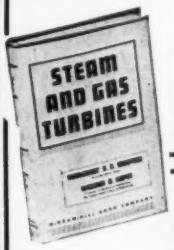

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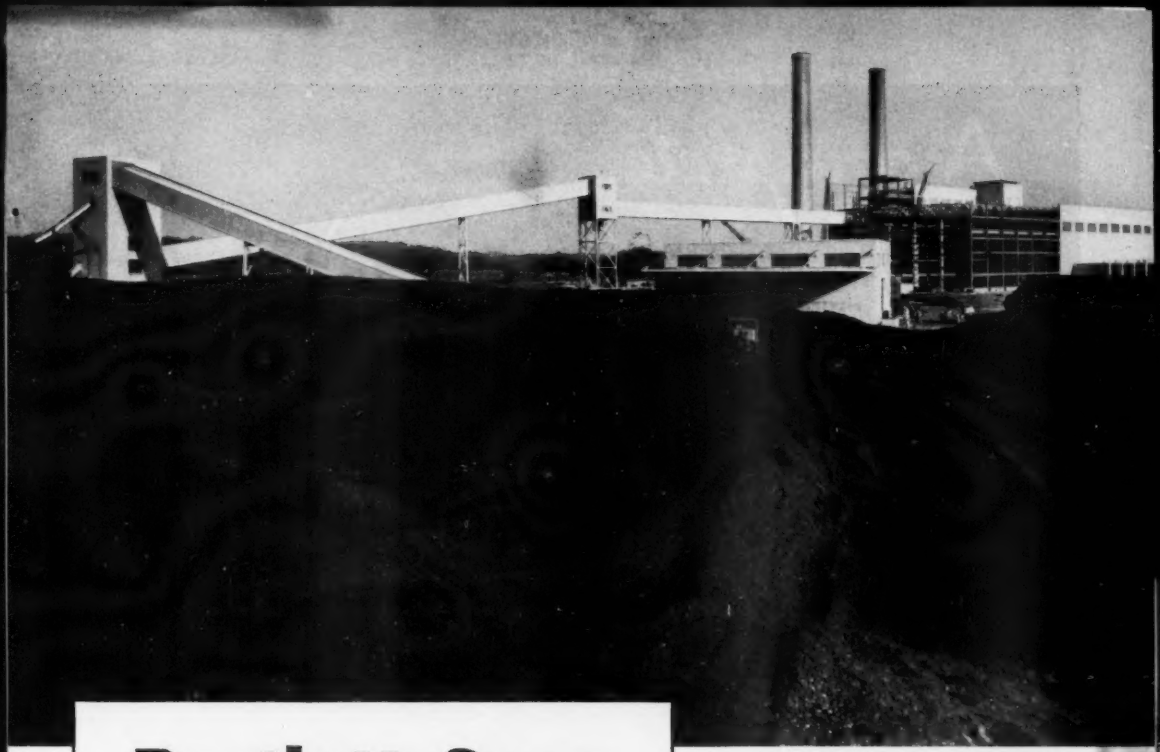

General View of O. H. Hutchings Station
Dayton Power and Light Company
Ebasco Services Incorporated
Consulting Engineers

Bartlett-Snow coal handling at Dayton

● The view above shows the first 120,000 KW unit of a plant which will be extended into a 360,000 KW station. The track and reclaiming hoppers, apron feeders, the three 700 ton per hour belt conveyors that total 1,178 feet in length, gates, chutes, and transfer points were detailed and fabricated in our shops and installed by our erectors to Ebasco Services Incorporated's specifications. For maximum efficiency and fixed unit responsibility, let the Bartlett-Snow coal handling engineers work with you on your next job.

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Track and Reclaiming Hoppers

Drive For 700 Ton Per Hour
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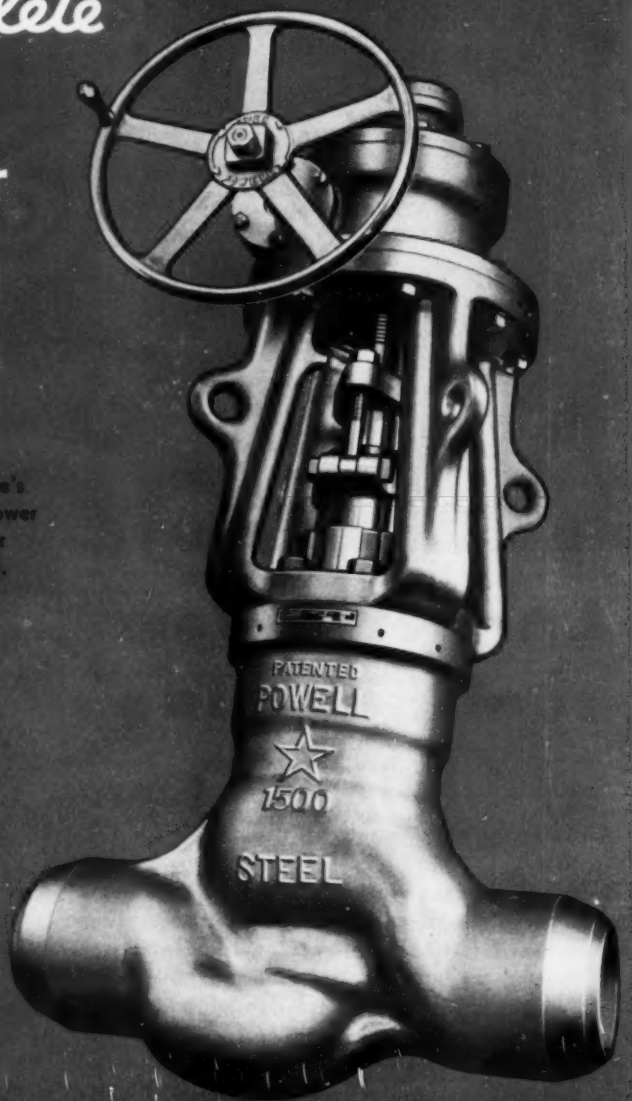

Fig. 11331. A 1500-pound Cast Steel Pressure Seal Globe Valve for Power Plant service. Welding ends and bevel gear operation. Its streamline design reduces pressure drop and turbulence within the valve to a minimum.

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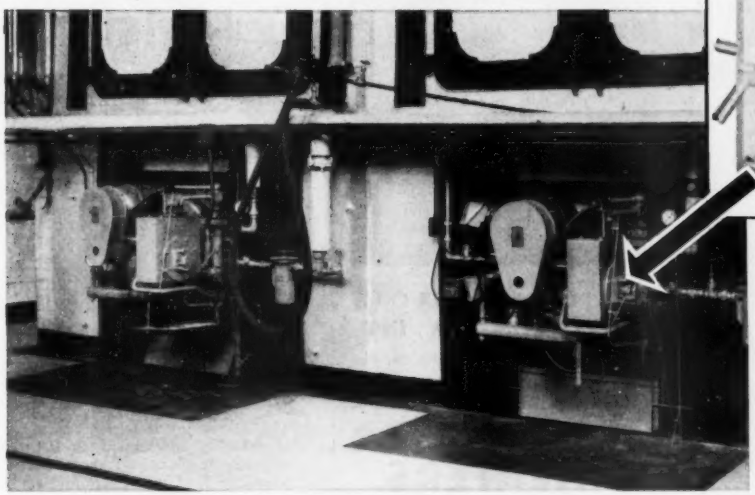

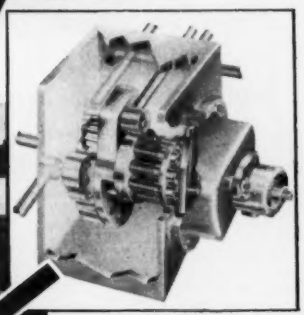

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The Iron Fireman Oil Volumeter is a variable volume pump which is completely submerged in the oil reservoir. Multiple pistons operating in a rotating cylinder-block pump the oil to the rotary cup nozzle under *low pressure*. Volume of oil delivered is regulated *accurately* by the length of the piston stroke, which is easily controlled either by automatic control systems or by manual adjustment. Oil feed rate stays within ½ of 1% of setting, regardless of changes in oil viscosity.

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fires heavy fuel oils with steady, uniform flame

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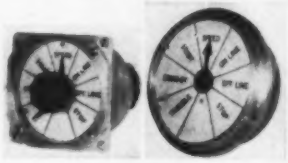

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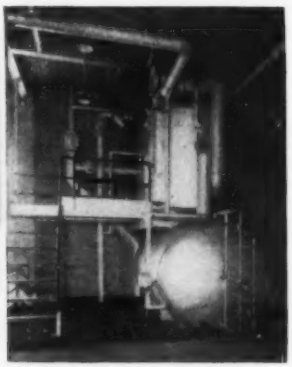
HOPPES FEEDWATER HEATERS



Deaerating feedwater heater serves as condensation return point for trapped and pumped returns from heating system

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For medium and high pressure Central Stations; modern Industrial and Process Plants; Steam Heating Plants and all Modern Power Plants which have boilers operating at medium and high pressures.

NON-DEAERATING:
For Laundries; small Industrial Plants; Institutions and all smaller Power Plants where boilers are operated at lower pressures and where economy of investment is desired.

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Deaerating heaters of plate type are designed for capacities up to 85,000 pounds per hour. Non-deaerating heaters include capacities up to 120,000 pounds per hour.

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(Integral Unit) Designed to meet space limitations, their outlet capacities range from 3,000 pounds per hour to 15,000 pounds per hour.

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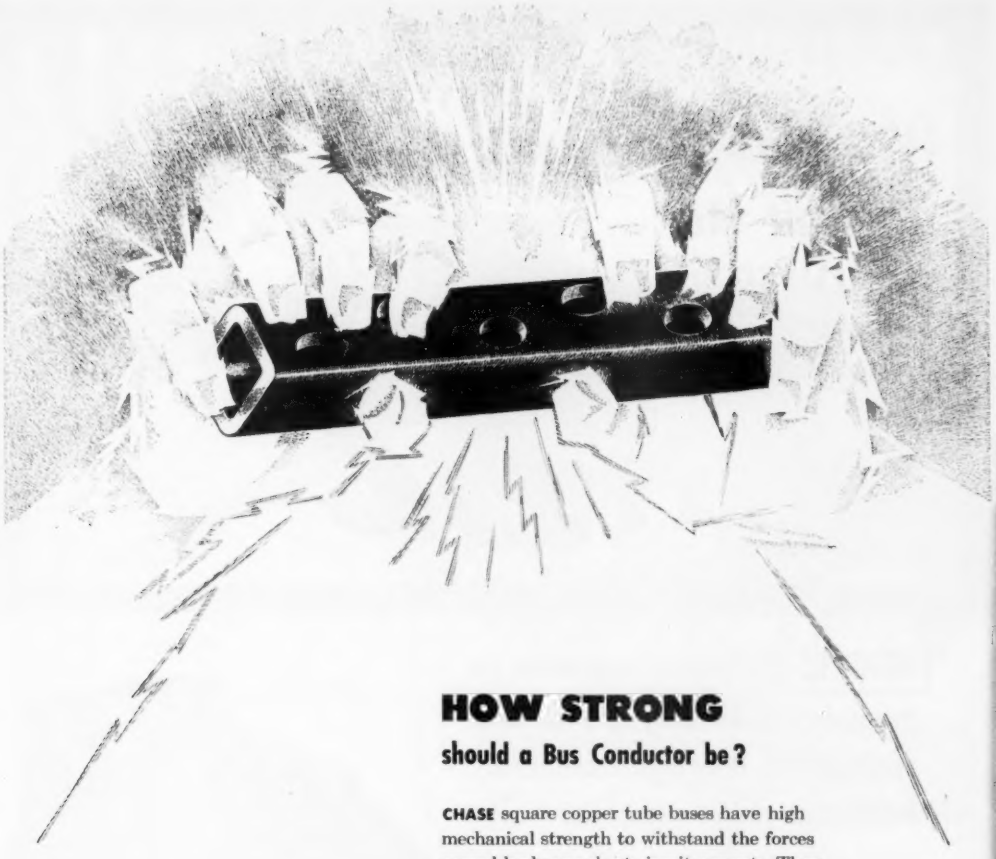

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We know it's no fun to wait for a BOILER

WICKES ENGINEERS appreciate the importance of hurrying up your boiler specifications, drawings, fabrication, installation and service.

When you are planning the installation of a new steam generator, you naturally want service in a hurry . . . right from the time the first drawings are made 'til the day you raise steam pressure.

You get service from Wickes before the sale and after the installation. We're big enough to engineer the kind of job you need and give you the kind of service you want.

From the standpoint of boiler efficiency, too, it pays to call on Wickes. In fact, Wickes has been designing and building good, dependable, boilers since 1854.

Write or phone your nearest Wickes representative or get in touch with our engineers here in Saginaw.

Wickes Type A Steam Generator

WICKES

127

THE WICKES BOILER CO.
SAGINAW, MICHIGAN
DIVISION OF THE WICKES CORPORATION

SALES OFFICES: Atlanta • Boston • Chicago • Cincinnati • Denver • Detroit • Houston • Indianapolis • Los Angeles • Milwaukee • New York City • Pittsburgh • Saginaw • San Francisco • San Jose • Springfield • Seattle • St. Louis • Tulsa • Mexico City • Buenos Aires • Manila • Havana • Montevideo • San Juan, P.R. • Victoria, B.C.

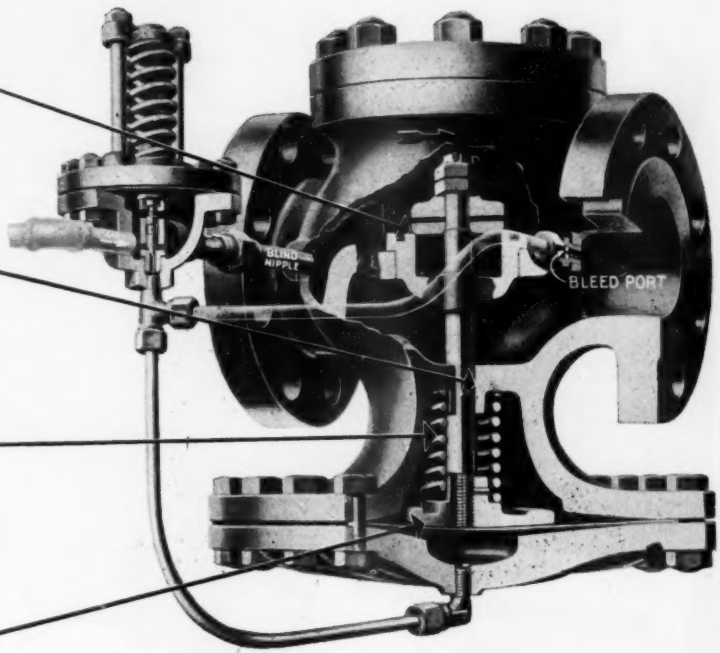
WHY Spence Regulators Outlast The Field

SECO METAL SEATS AND DISCS — Durable SECO Metal resists wiredrawing. More than *twenty years of experience* in thousands of installations has failed to produce a single case where SECO Metal has been cut by steam.

PACKLESS CONSTRUCTION — All Spence main valves and most pilots are built without stuffing boxes. This minimizes friction . . . eliminates much time-consuming maintenance.

SPRING OUT OF PATH OF STEAM — The spring in the Spence Regulator is out of the path of the steam or other fluid flowing through the valve. It operates at low unit stress for exceptionally long life.

LARGE BALANCED DIAPHRAGM—Spence metal diaphragms, under usual conditions, never require replacement. Spence Regulators have few moving parts and those few are ruggedly constructed and seldom require attention.



Spence Type EQ back pressure regulator — operation of main valve is controlled by a sensitive pilot to regulate the initial pressure. Same pilot is used with all sizes of main valves.

The features shown above explain why you profit on every important count with Spence Pressure and Temperature Regulators.

Learn more about these and many other advantages of Spence Regulators by sending for Bulletin 350.

DURABILITY — Spence Regulators perform dependably year after year.

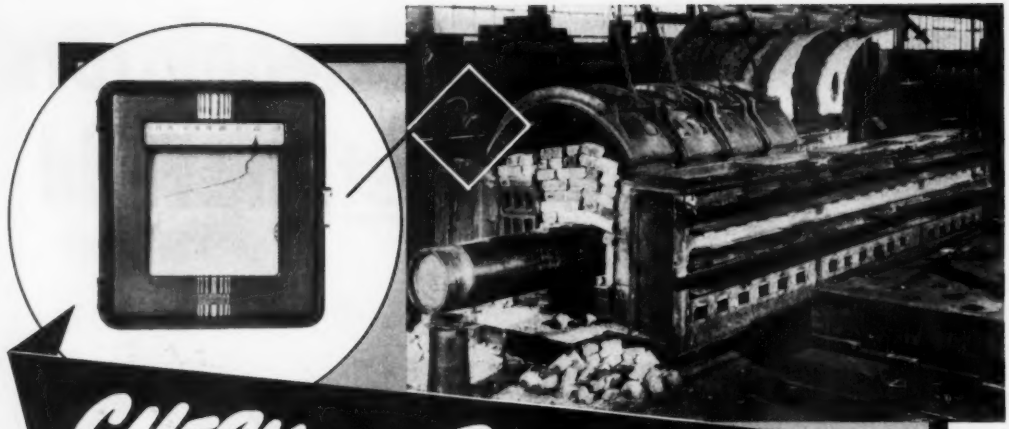
ACCURACY — You can be sure of accurate control for the life of the regulator.

MAINTENANCE — You don't need expensive repairs or special maintenance. That means less down-time, less time and money wasted on replacement of parts.

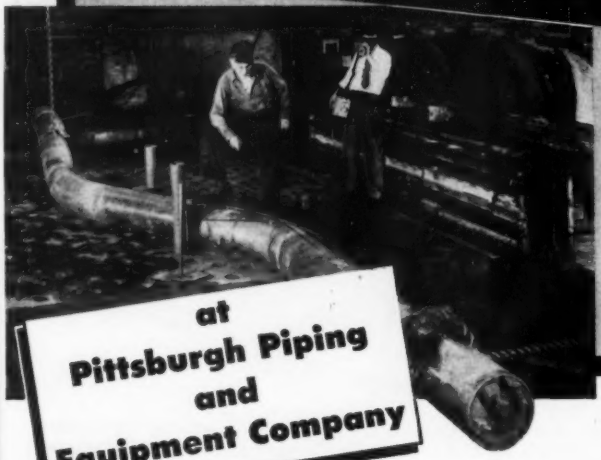
SE-110

SPENCE ENGINEERING COMPANY, INC.
WALDEN, NEW YORK

Spence



CHECK and DOUBLE CHECK



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on HEAT TREATING and BENDING TEMPERATURES

The temperature to which P.P.&E. piping is subjected before bending is measured by a Ray-o-Tube which projects through the furnace wall . . . and recorded on the chart of the Micromax instrument.

This time-temperature record makes practicable precise control of conditions so that each section of pipe is heated in conformance with a predetermined routine which assures consistent physical and mechanical properties.

After the pipe is taken from the furnace, it is immediately placed on a bending table, and during the bending process its temperature is periodically checked with an optical pyrometer by a trained, experienced observer.

You can depend on Pittsburgh Piping and Equipment Company for leadership in methods that assure greatest safety, highest efficiency, and longest service from high temperature, high pressure piping.

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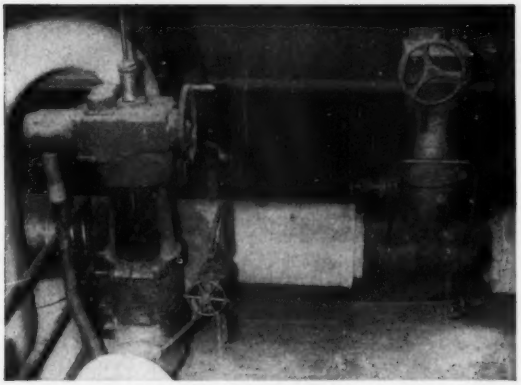
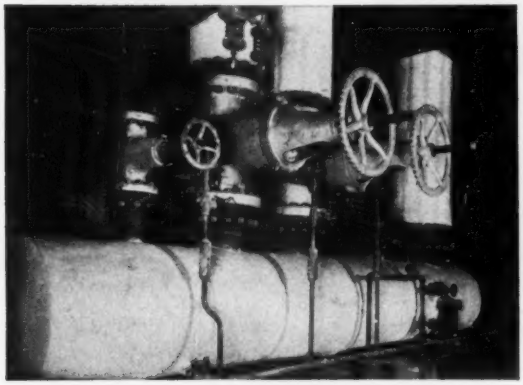
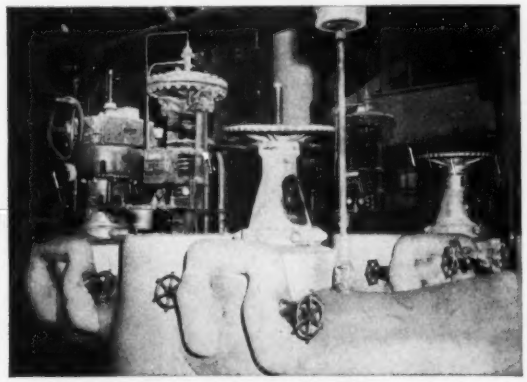


Walworth Motor Operated Series 900 Pressure-Seal Cast Steel Gate Valves.



Walworth Series 600 Pressure-Seal Cast Steel Gate Valves.



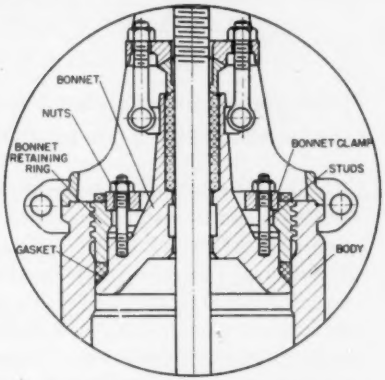
Manually operated and motor operated Walworth Series 900 Pressure-Seal Cast Steel Gate Valves.

WALWORTH PRESSURE-SEAL CAST STEEL VALVES

The bonnet and body design of Walworth Pressure-Seal Valves is such that the pressure within the valve is used to prevent leakage at the junction of the bonnet and body. Sudden temperature and pressure changes do not affect this tightness. Bonnet flanges and studs are eliminated and the weight of the valve is reduced.

An improved disc design provides flexibility, and helps keep seats tight, even when the valve body may be distorted by pipeline stresses, or by temperature and pressure changes. This improved disc design makes it easier to open and close this valve.

Walworth Pressure-Seal Valves are easy to disassemble and assemble, and are the most satisfactory valves for high-pressure, high-temperature service. They are available in Series 600, 900, and 1500 and in a wide range of sizes and types. For further information, see your nearest Walworth Distributor, or write: Walworth Company, 60 East 42nd Street, New York 17, N. Y.



A cross section of the bonnet joint assembly of a Walworth Pressure-Seal Cast Steel Gate Valve. The internal pressure is utilized to make the body-to-bonnet joint tight.

WALWORTH
valves and fittings
60 EAST 42nd STREET, NEW YORK 17, N. Y.

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BUELL VAN TONGEREN CYCLONES

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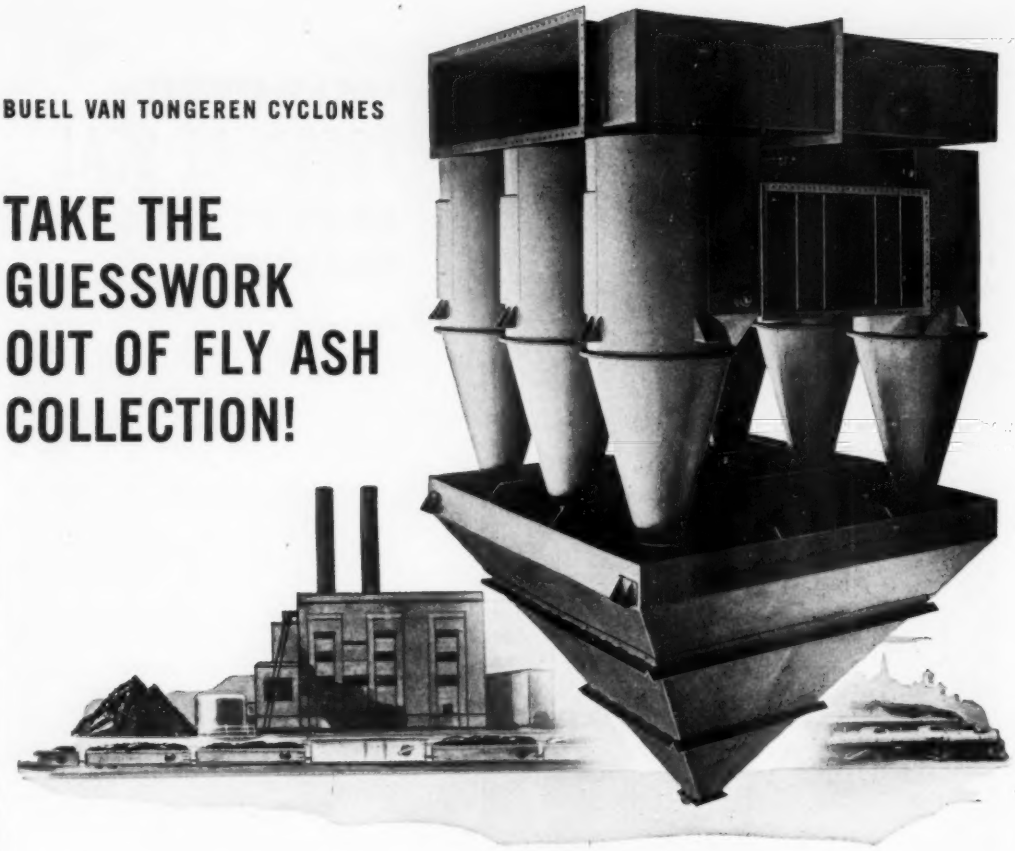

Now you know beforehand that you can collect the nuisance-size particles from pulverized coal-fired boilers.

If you want a definite, dependable statement on the actual 'delivered' efficiency of a Fly-Ash Collection System, ask Buell.

Buell's van Tongeren Cyclone Dust Collector, with Guaranteed Fractional Efficiency, gives you an accurate estimate of collector performance *before* your installation is made. Guesswork is out! Known, sustained peak efficiency is in!

For sound counsel on either Fly-Ash Collection or Valuable Dust Recovery problems, Buell engineers can prove invaluable. Write today for a consultation without obligation, or ask for the latest Buell catalog which discusses Buell Cyclones, Low-Draft-Loss Collectors, and Buell 'SF' Electric Precipitators. Buell Engineering Co., 70 Pine St., Suite 5045, New York 5, N.Y.

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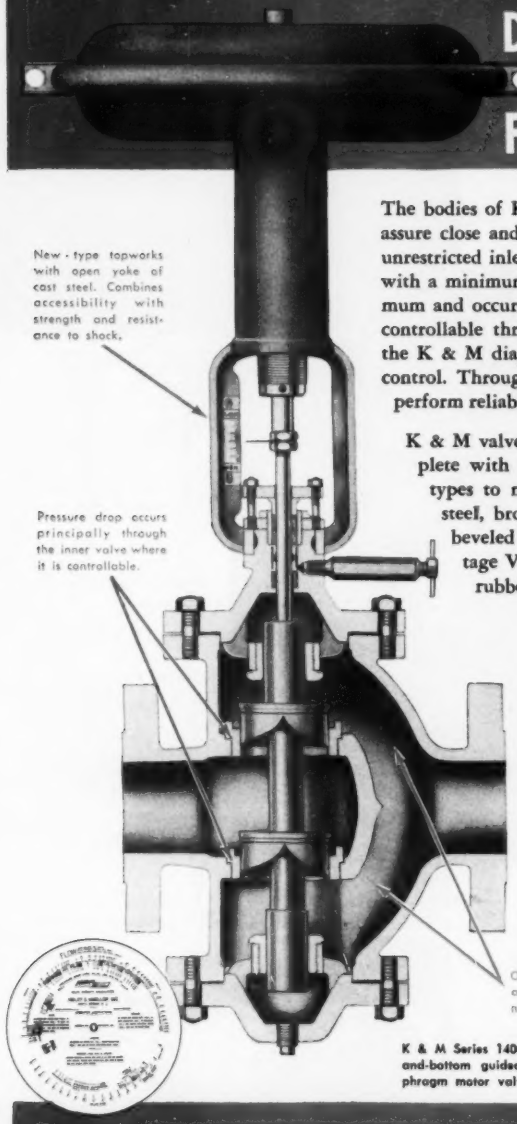
Engineered Efficiency in **Fly Ash Collection**

K&M

The Control Valves DESIGNED ESPECIALLY FOR INSTRUMENTATION

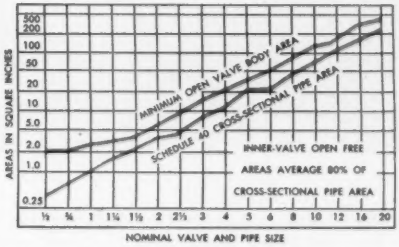

New - type topworks with open yoke of cast steel. Combines accessibility with strength and resistance to shock.
Pressure drop occurs principally through the inner valve where it is controllable.
Over-size, streamlined body areas reduce turbulence and friction to a minimum and assure smooth, maximum flow.

K & M Series 1400 top-and-bottom guided diaphragm motor valve.

The bodies of K & M Control Valves are especially designed to assure close and positive control by instrumentation. They have unrestricted inlet and discharge passages and permit smooth flow with a minimum of turbulence. Pressure drop is held to a minimum and occurs principally through the inner valve where it is controllable through the full valve travel. The construction of the K & M diaphragm motors assures extreme precision in this control. Throughout, K & M Control Valves are engineered to perform reliably in *the most exacting applications.*

K & M valves are available in sizes from ½ to 20-inch, complete with diaphragm motor and are made in 13 different types to meet varying requirements. Constructed of semi-steel, bronze, cast steel or special alloys. Inner valves in beveled quick opening, percentage parabolic or percentage V-port design as standard. Facings range from soft rubber to stellite.

Because of their modern design, all K & M valve bodies have extremely high capacities in relation to corresponding pipe size:



This extremely accurate circular slide-rule type K & M valve capacity calculator includes correction scales for steam quality, liquid and gas specific gravity and a flowing temperature scale for gases. Sent without charge in response to a request on your business stationery.

KIELEY & MUELLER

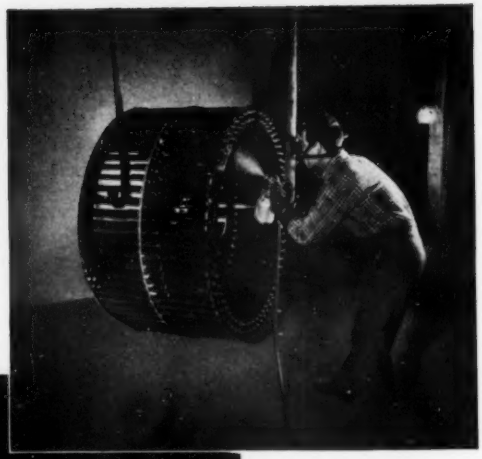
Established 1879

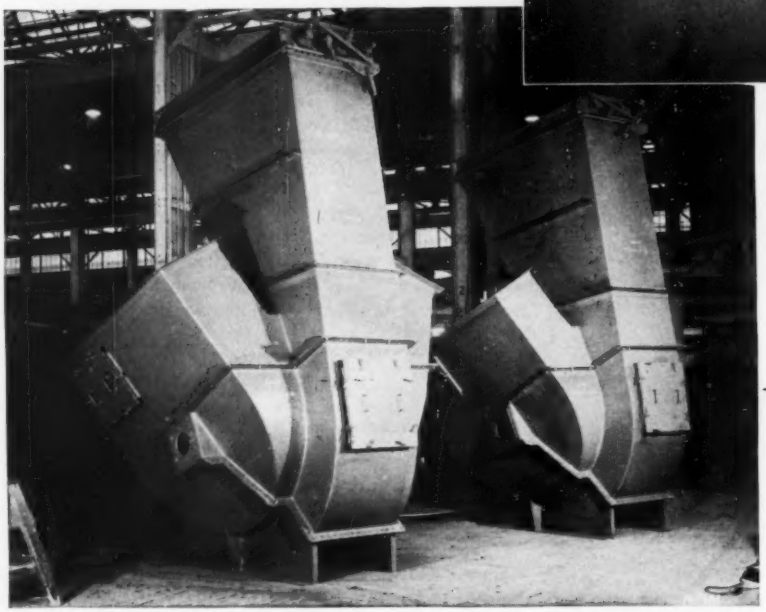
2031—43rd Street North Bergen, N. J.

Mechanical Draft Fans
for
The City of Cleveland Municipal Power Plant

Boiler Contractors: Foster Wheeler Corporation

To meet ever-increasing demand for electric power, still another of America's great public utilities, The City of Cleveland, is expanding and enlarging its facilities and services.





Above is shown one of the 51½" Sirocco Wheels receiving its final coat of paint. The unique and scientific design of the Sirocco Wheel provides for unusual structural strength as well as unobstructed air flow.

Here are two of four American Blower Induced Draft Fans destined for the City of Cleveland Municipal Power Plant. Each fan is rated at 105,200 cfm at 375° F. at 13.5" static pressure. An order for four American Blower Forced Draft Fans is also in the process of construction. This is the second order of similar fans for the City of Cleveland.

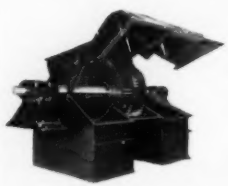
High static efficiency, low RPM, low tip speed, low inlet velocity, plus other important operating characteristics, make American Blower Mechanical Draft Fans well adapted to severe power plant requirements.

For further data, consult your nearest American Blower Branch Office.

AMERICAN BLOWER CORPORATION, DETROIT 32, MICHIGAN

CANADIAN SIROCCO COMPANY, LTD., WINDSOR, ONTARIO

Division of American Radiator & Standard Sanitary corporation



Sirocco Induced Draft Fan

This type of Induced Draft Fan is being used on 1,000,000 #/hr. steam boilers.

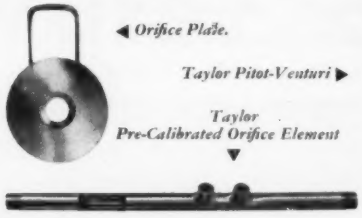
YOUR BEST BUY AMERICAN BLOWER POWER PLANT EQUIPMENT

Serving home and industry

AMERICAN-STANDARD · AMERICAN BLOWER · CHURCH SEATS · DETROIT LUBRICATOR · KEWANEE BOILERS · ROSS HEATER · TONAWANDA IRON

LET TAYLOR HANDLE YOUR FLOW PROBLEMS

• PRIMARY ELEMENTS



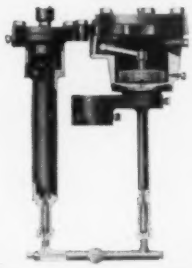
◀ *Orifice Plate.*

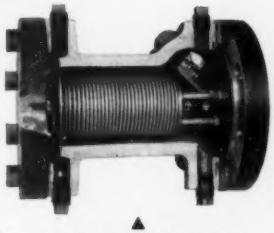
Taylor Pitot-Venturi ▶

Taylor Pre-Calibrated Orifice Element ▼

(1) Thin and thick type Orifice Plates from 2 to 24" in all standard materials. (2) Pre-Calibrated Orifice Assembly for high-accuracy with pipe sizes less than 2" are a "Specialty of the House" with Taylor. (3) The new and exclusive Taylor Pitot-Venturi Flow Element which produces greater differential with practically no pressure loss—7 to 10 times greater than by the conventional Pitot Tube. (4) Also standard Venturi Tubes. (5) Flow Nozzles from 3 to 14" in all standard materials.

• FOR MEASUREMENT



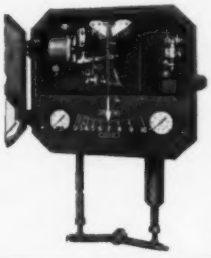


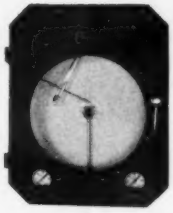
▲ *Taylor Aneroid Manometer*

◀ *New Taylor Mercury Manometer*

(1) New Taylor high-accuracy Mercury Manometer which features Teflon bearings, high energy output, submerged check valves, ½ of 1% accuracy, an adjustable leakless damping unit, and interchangeable range tubes for continuous ranges from 10 to 533 inches of water. (2) Taylor Aneroid (Mercury-less) Manometer, available in All-316 Stainless Steel or Cast Steel, accurately measures flow of hard-to-handle corrosive materials. No mercury to replace, no stuffing box. Sealing fluids or blow-back systems seldom needed. Long service. Easy cleaning. Easy range changes. Both Manometers available with Square Root Integrators.

• FOR TRANSMISSION





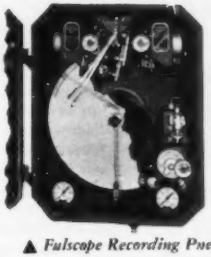
▲ *Fulscope* Recording Receiver Controller*

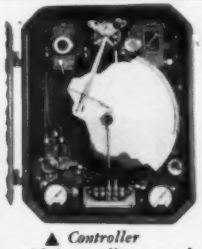
◀ *Taylor Indicating Transmitter*

Taylor Remote Transmission Systems accurately, quickly, economically, and safely transmit rate of flow to conveniently located point. Transmitters can be indicators, recorders or controllers. High accuracy—systems are calibrated to within ½ of 1% accuracy. High speed—only 2-second lag in 300 feet. Gives central control of widely distributed processes at one convenient point. Concentric dial transmitter with Mercury Manometer also available.

*Trade-Mark

• FOR CONTROL





▲ *Controller with internally mounted automatic-manual unit*

▲ *Fulscope Recording Pneumatic-Set Flow Controller*

Indicating or recording controllers in single or double duty form, with adjustable sensitivity or automatic reset. Ratio Flow Controllers with two Manometers attached. Control point may be adjusted by any other process variable. Pneumatic-set controllers whereby control point can be pneumatically adjusted from any remote location. Internally or externally mounted automatic to manual units.

• • •

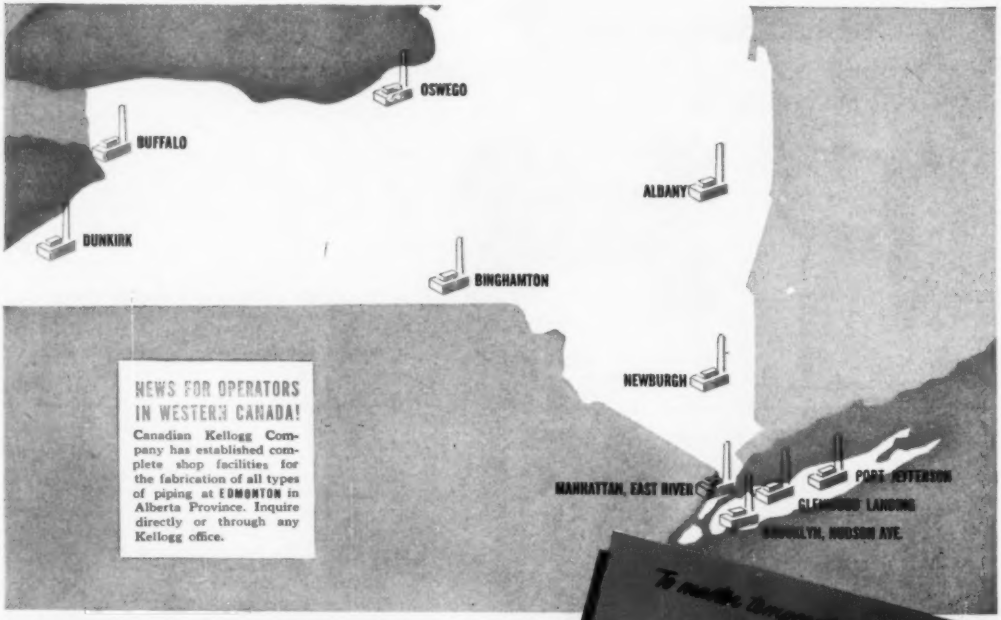
For complete details, write for new Flow Catalog 98175, or ask your Taylor Field Engineer. He'll show you how Taylor Instrumentation can help you solve *any* flow problem. Taylor Instrument Companies, Rochester, N. Y., and Toronto, Canada.

Taylor's Centennial ACCURACY FIRST SINCE 1851

TAYLOR INSTRUMENTS MEAN ACCURACY FIRST

Note: Over 1,250,000 kws for New York State alone!

...within a very short space of time, we have contracted to fabricate the major power piping for over 1,250,000 kws. of additional steam power capacity for New York State alone. Most of these orders include job-site installations as well. All piping is for modern high-pressure, high-temperature systems — predominantly of the reheat type — with operating temperatures of 1000°F. or higher. When completed these new power installations will expand the state's total steam-generated capacity by well over 20%.



NEWS FOR OPERATORS IN WESTERN CANADA!

Canadian Kellogg Company has established complete shop facilities for the fabrication of all types of piping at **EDMONTON** in Alberta Province. Inquire directly or through any Kellogg office.

Special studies of unusual problems such as graphitization to assure long life and low maintenance.

Metallurgical research by recognized specialists who have made major contributions in this field.

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Exclusive Equipment for accurately analyzing stresses in piping and providing unique data for critical installations.

Complete facilities for the fabrication of steel products from simple forgings to specially cast bi-metallic devices.

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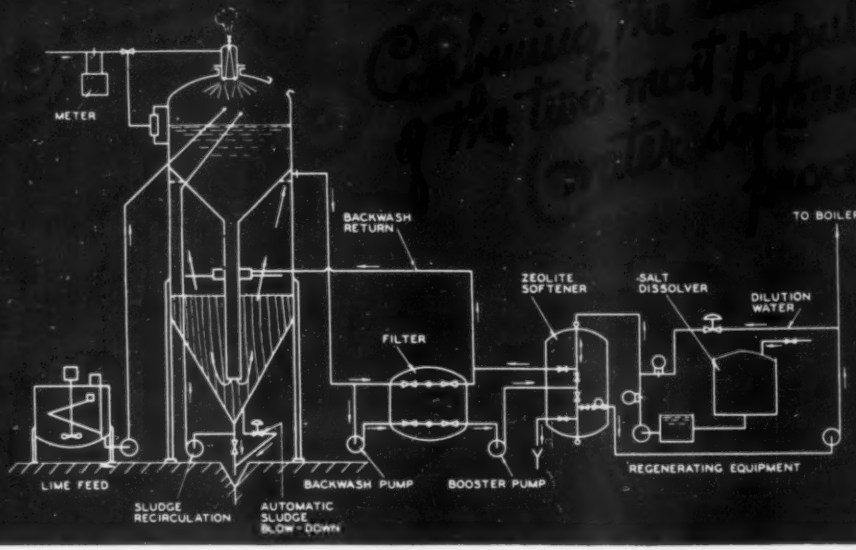
The M. W. Kellogg Company, (A Subsidiary of Pullman Incorporated) — Offices in New York, Jersey City, Buffalo, Los Angeles, Tulsa, Houston, Toronto, London and Paris.

cochrane hot process zeolite water conditioner



1. saves chemicals
The zeolite softener uses salt instead of the more expensive soda ash and phosphates, bringing down the cost of chemicals considerably.

2. saves on capital investment The cost of adding zeolite equipment to a hot process installation is far less than the addition of an independent sedimentation tank and chemical feed for a two-stage phosphate process.

3. lower CO_2 in steam
The lower alkalinity resulting from using lime alone, plus the fact that this alkalinity is all carbonate, causes a reduction in CO_2 generated in the steam.

4. less operating attention The use of the zeolite softener with its simplicity of operation is an advantage which is enhanced by the longer periods between regenerations, due to the lower hardness of the hot process softener effluent.

5. less floor space and head room required
The addition of the zeolite equipment requires less floor space and less head room than that required for two stage phosphate equipment.

6. lower alkalinity The use of lime (or Dolomitic lime) as the sole reagent in the hot process means that the alkalinity can be reduced to about half that obtained with lime and soda ash.

7. only one chemical needed in the hot process It is generally possible to use a single reagent in the hot process, namely lime or Dolomitic lime, precipitating the bicarbonates and magnesium, leaving the remaining hardness to be removed by the more economical zeolite.

get the facts about this economical process use this coupon

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HOW TO AVOID THE 3 COMMON CAUSES OF BOILER WALL FAILURE

If high heat, slag penetration and abrasion at the clinker line are causing you frequent shutdowns and excessive maintenance costs, it's time to investigate Norton Crystolon (silicon carbide) shapes . . . hollow air-cooled blocks or solid bricks.

Proved Properties

1. Norton Crystolon shapes are highly refractory . . . successfully resist temperatures up to 3100°F.

2. Made in very dense form with a maximum percentage of silicon carbide, they effectively resist slag penetration. In rare cases when clinkers do adhere, you can easily remove them without damage to the refractory.

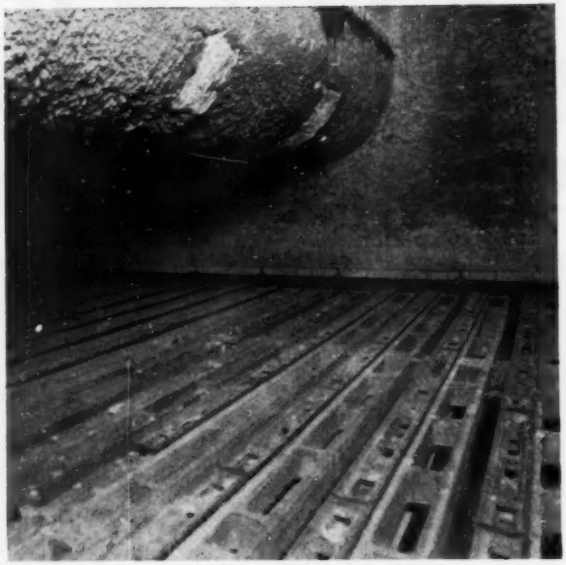
3. Since silicon carbide is a tough abrasive, Norton Crystolon blocks and bricks are not noticeably affected by the abrasion of the moving fire bed of stoker-fired furnaces.

All Shapes

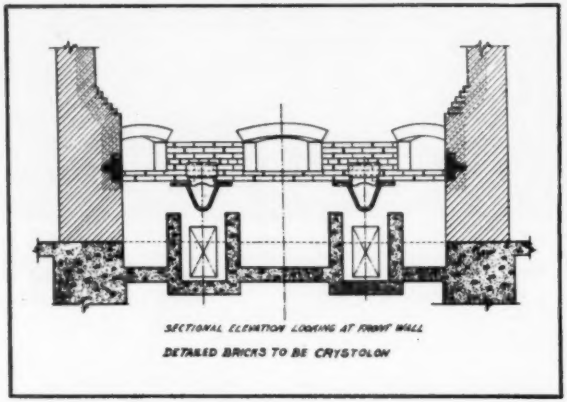
Norton Crystolon air-cooled blocks and solid bricks, with mating tongues and grooves for easy installation, come in any size and shape your furnaces call for. Norton Type A (rectangular), Type B (T-shaped) and Type C (U-shaped) blocks and bricks are also available for replacement purposes.

Get All The Facts

For more complete information about Norton Crystolon silicon carbide shapes, consult your nearby Norton representative, or write direct for Bulletin 862. NORTON COMPANY, 601 New Bond Street, Worcester 6, Mass.



LOWER MAINTENANCE COSTS in boiler furnaces result from Norton Crystolon* (silicon carbide) brick at the clinker line, thanks to their high refractoriness, resistance to slag penetration and to abrasion.



NORTON CRYSTOLON BRICKS, as detailed in this front wall elevation, quickly pay for themselves where spalled, eroded or cracked refractories previously have caused frequent shutdowns.

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Making better products to make other products better

Special REFRACTORIES

Canadian Representative

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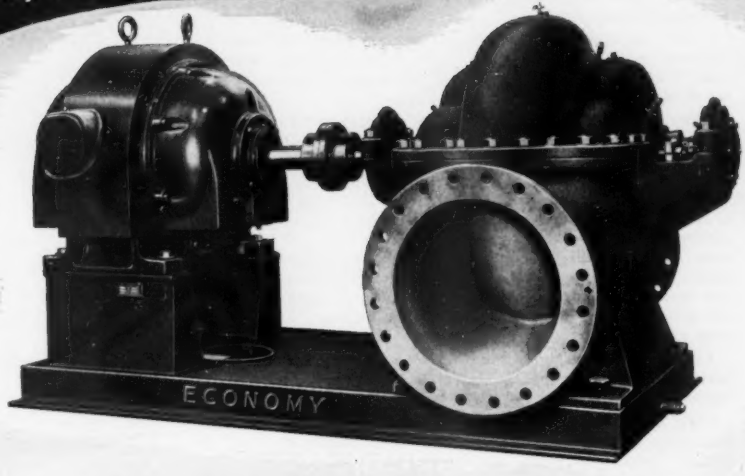
when it's pumps, think of Economy

backed by over thirty years of specialized experience



The Type M Single Stage Double Suction Pump illustrated is just one of the many in the extensive line manufactured by Economy Pumps, Inc. This exceptionally rugged design is available in capacities from 50 to 30,000 gallons per minute at heads to 300 feet. A general purpose pump, it is ideally suited to general water supply or heavy mill service.

Maintenance expense is held to a minimum. Case records show Economy Pumps operating for fifteen to twenty years without replacement of major parts. However, should repairs be necessary, all parts subject to wear are renewable.

Economy Pumps are tested in accordance with the standards of the Hydraulic Institute and the A. S. M. E. under conditions duplicating as nearly as possible those encountered in actual service.

Catalog No. A750 gives complete design and construction details, also some interesting typical examples of performance, as well as handy selection tables. Write Dept. BC-3 for your copy.

Economy Pumps Inc.

DIVISION OF HAMILTON-THOMAS CORP., HAMILTON, OHIO

How and Where?

...Ross answers today's 2 big questions about heat exchangers

As all of us get deeper and deeper into the defense program, the questions "how" and "where" will obviously become more important and more frequent.

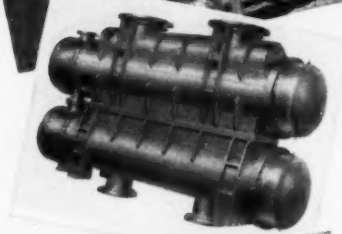
Today's the time, we think, to give you *our* answer to these vital questions, with respect to heat exchanger procurement. And we aim to make it a helpful answer . . . one that will accomplish the most good for all of us.

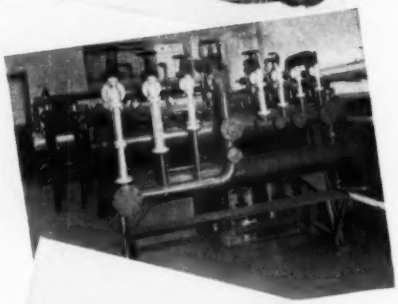
HERE'S WHAT WE CAN PROMISE . . . *DEFINITELY!* Ross can take over *your* problems *faster* . . . saving much of *your* time. As the pioneer and most advanced in heat exchanger standardization, Ross has the engineering know-how and the plant facilities to get your job going *sooner* . . . the knowledge and the skill to do it *better!* This applies to all types of heat transfer and allied equipment—exchangers, surface condensers, steam jet vacuum equipment—either fabricated from stock parts and standardized designs, or specially engineered from the ground up. And it applies to every phase of today's domestic and military needs—chemicals • plastics • power • synthetic rubber • powder • petroleum • metals—the same as it applies to fighting vessels • cargo ships • trucks—

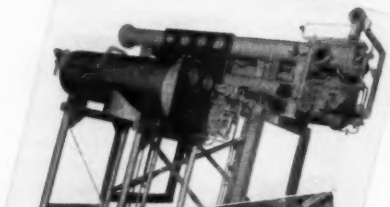
Yes, our answer to "how" and "where" is "HERE"! For, no matter what your problem or application, Ross is a ready source of time-saving methods.

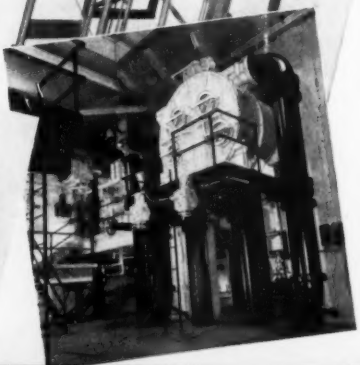
ROSS HEATER & MFG. CO., INC., Division of American Radiator & Standard Sanitary Corp., 1415 West Avenue, Buffalo 13, N. Y. In Canada, Horton Steel Works, Limited, Fort Erie, Ont.

BUILT TO T. E. M. A. STANDARDS As a member of the Tubular Exchanger Manufacturers Assn., Ross fabricates in accordance with the published thermal and mechanical standards of T. E. M. A.



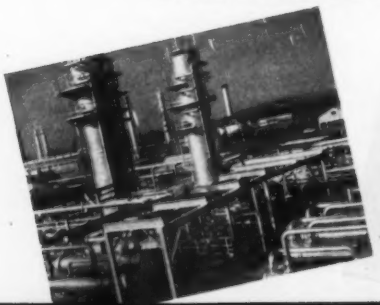


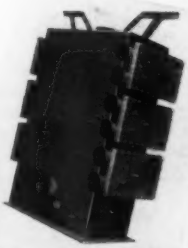




ROSS

EXCHANGERS





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FLUOR MUFFLERS

. . . a guide for your preliminary study of mufflers and muffling requirements

This new Fluor muffler bulletin is designed to assist you in the selection and sizing of mufflers for 2- and 4-cycle internal combustion engines in the 150 to 2400 H.P. class.

It is a concise presentation of engineering data complete with cutaway and dimensional drawings and sizing and engine selection tables – ideal for preliminary study of muffling requirements or for specifying the type muffler best suited for your particular requirements.

A Few of the Subjects Covered . . .

- Design principles and applications for air-cooled and non-air-cooled mufflers.
- Cutaway drawings of both single and dual element mufflers.
- Dimensional drawings and tables of sizes and weights.
- Recommended sizes according to engine model numbers and horsepower ratings.
- Mufflers for Twin-Tandem Horizontal Gas Engine-Driven Compressor Units.
- Standard Models and arrangements of single and dual element mufflers.
- Basic design data required for quotation.

SPECIFY FLUOR BULLETIN NO. FM-8501

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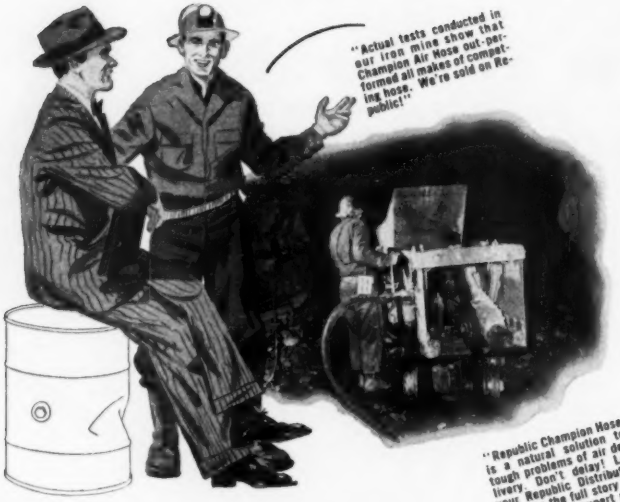
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Republic's Champion Air Hose is colored yellow for safer visibility. It's specially fabricated for added strength and flexibility without any increase in over-all hose weight.

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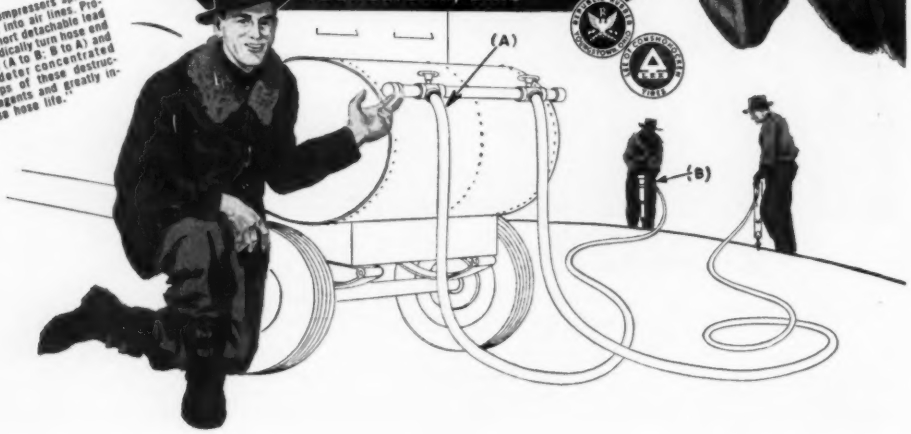
"Most compressors spit oil and heat into air lines. Provide a short detachable lead or periodically turn hose end for end (A to B, B to A) and you'll deter concentrated buildups of these destructive agents and greatly increase hose life."



ERIEZ MAGNETIC ATTRACTIONS

ERIEZ MANUFACTURING CO., ERIE, PA., U.S.A. • PRODUCERS OF MAGNETIC SEPARATORS AND SELLERS OF (RCA) ELECTRONIC METAL DETECTORS

IT'S A FACT...734,254 BEEF LIVERS AND 5956 CARCASSES WERE CONDEMNED IN A YEAR BECAUSE OF ABSCESS AND PERICARDITIS CAUSED BY ***TRAMP IRON*** IN CATTLE FEED LOSS...OVER 3 MILLION DOLLARS! ***ERIEZ*** **ATOM**AGNETS FIGHT THIS BECAUSE THEY WON'T LET TRAMP IRON PASS.

TO KEEP THE WALLS UP THEY USED ***ERIEZ*** PERMANENT PLATE MAGNETS IN GRAVITY FLOW CHUTES AT AN OHIO CHEMICAL PLANT. WITHOUT THIS PROTECTION FROM TRAMP IRON SPARKING, EXPLOSIONS WERE SO FREQUENT.... 9 A DAY AVERAGE.... THAT THE WALLS WERE MADE TO FALL OUTWARD AT THE SLIGHTEST BLAST TO AVOID MAJOR DAMAGE!

.....SINCE INSTALLATION..... **NO EXPLOSIONS!**

YOU DON'T HAVE TO BEAT THIS DRUM ...FOR RESULTS. THE ***ERIEZ*** *MAGNETIC DRUM* AUTOMATICALLY REMOVES STRAY IRON.... SOME DANGEROUS TO MACHINERY.... SOME THAT CAN BE SOLD. *USED IN EVERY INDUSTRY!*

FIVE DOLLARS SAVED A YEAR FOR EACH DOLLAR INVESTED... THE RESULT OF ***ERIEZ*** MAGNETIC HUMP SEPARATOR INSTALLATIONS AT A SOUTHERN TEXTILE PLANT...***WOODSIDE MILLS.*** AVERAGE NUMBER OF FIRES *BEFORE* ***ERIEZ*** HUMPS WERE IN...*12* PER YEAR! *AFTER INSTALLATION*..... NO FIRES...NO PRODUCTION DELAYS!

RETURN THIS COUPON.

ERIEZ MANUFACTURING COMPANY
207 STATE STREET, ERIE, PA.

MY CONTAMINATION OR SEPARATION PROBLEM IS:

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PLEASE SEND LITERATURE ☐
HAVE REPRESENTATIVE CALL ☐ PROMPTLY ☐ WHEN IN AREA

NAME _____
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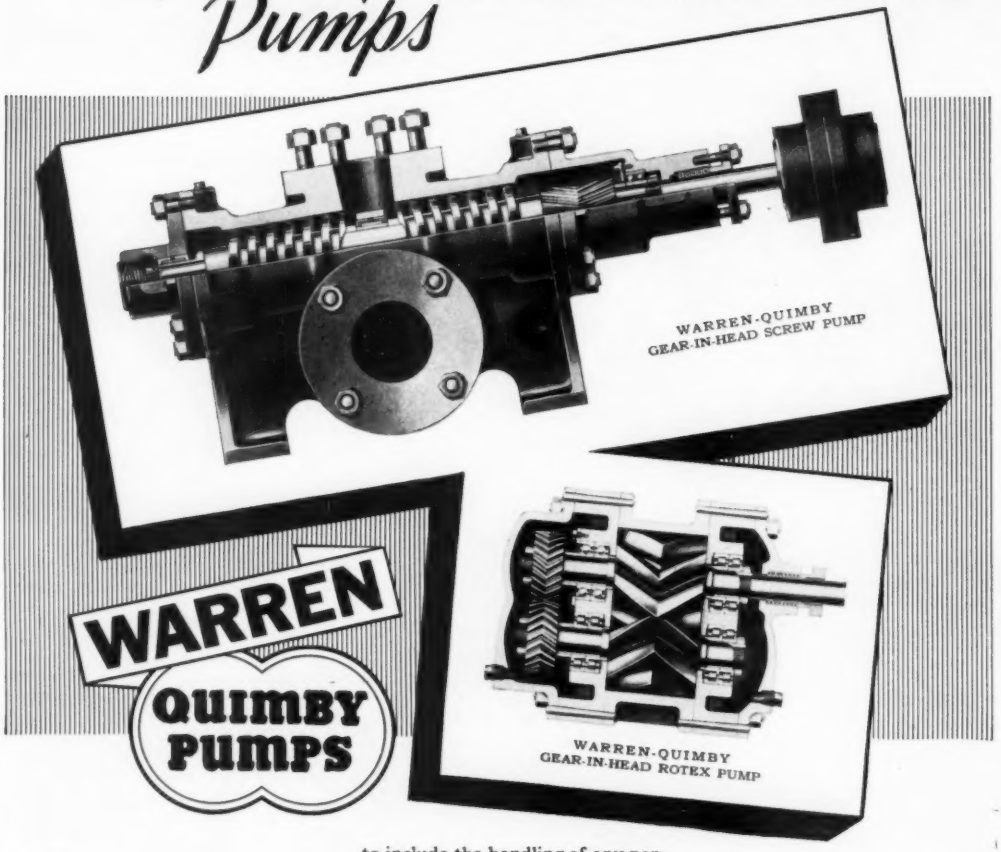
SIC

NOW *Quimby Pumps* WITH WARREN SERVICE

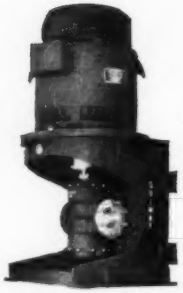


Now you can look to Warren for Screw and Rotary pumps as well as Centrifugal and Reciprocating types.

Quimby built the first balanced quadruplicate screw pump in 1893. The salient design feature of separate screws and timed driving gears have never been changed. However, refinements through the years have widened the scope of applications to include the handling of any non-abrasive liquid or semi-liquid at moderate and high pressures.

The "Rotex" is a superior rotary pump of unique construction that has numerous applications where moderate pressures are involved.

We are glad to add these new members to the Warren family and invite your inquiries on any problem involving Screw and Rotary, Centrifugal or Reciprocating Pumps.



Both Screw and Rotex type pumps are available either horizontal or vertical mounted.

PQ-2

WARREN PUMPS

WARREN STEAM PUMP COMPANY, INC., WARREN, MASSACHUSETTS

You Save on 4 Counts with ENCO STREAMLINED BAFFLES

1 Better heat transfer

Enco's improved baffle design insures a uniform, high velocity gas flow over every square foot of heating surface.

2 Low draft loss

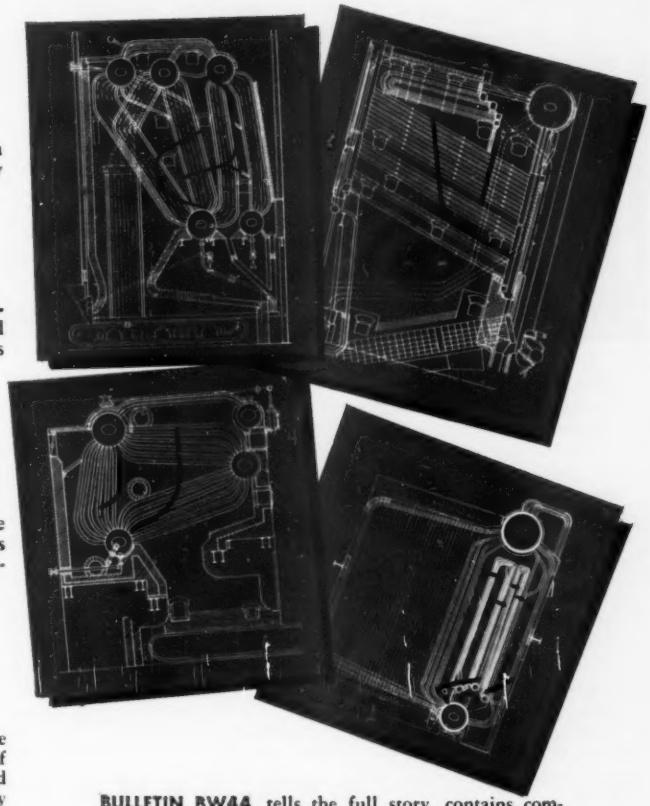
Smoothly curved baffles maintain a cross-flow of gases across the tube banks. Dead gas areas, bottlenecks and eddy currents are eliminated.

3 Less steam, less time for cleaning

Soot doesn't get a chance to accumulate in pockets. Soot blowers are used less often. Streamlined baffles lower maintenance costs.

4 Custom installation

Experienced Enco crews take charge of the installation, repairs and replacements of your individually designed streamlined baffles—do the job thoroughly and quickly with minimum downtime.



BULLETIN BW44 tells the full story, contains complete engineering data, explains how Enco Baffles provide maximum steam output with minimum fuel consumption. WRITE FOR YOUR FREE COPY TODAY!

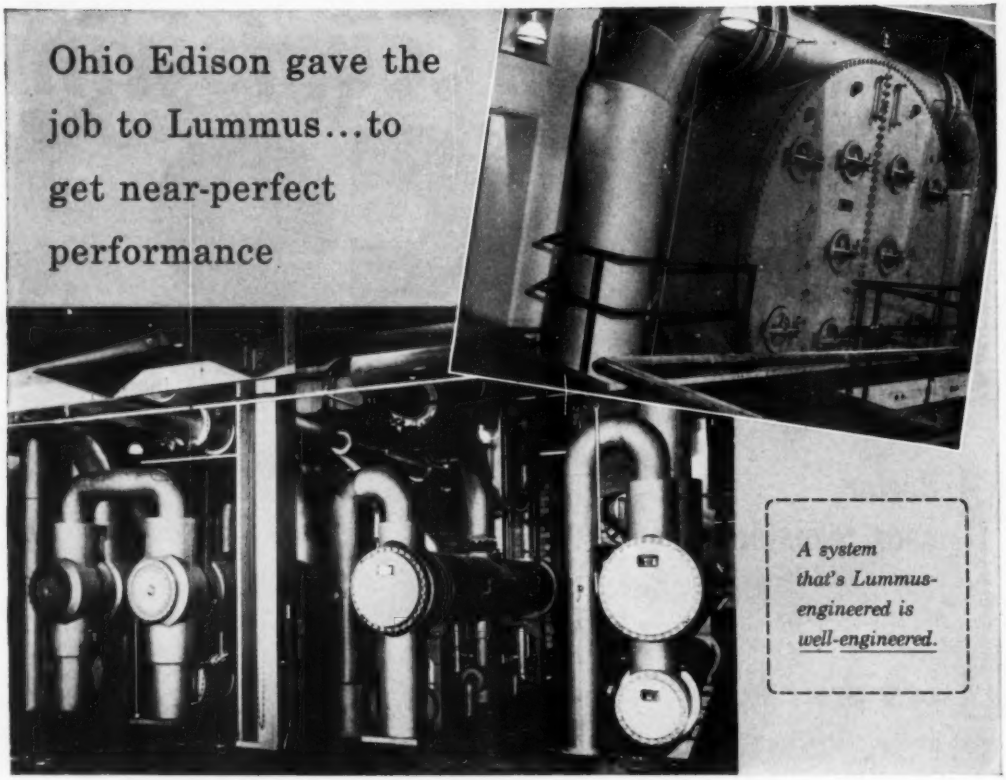
THE ENGINEER COMPANY

75 WEST STREET, NEW YORK 6, NEW YORK

IN CANADA: F. J. RASKIN, LTD., 4220 IBERVILLE ST., MONTREAL 34 P.Q.

EC-481

Ohio Edison gave the job to Lummus...to get near-perfect performance



A system that's Lummus-engineered is well-engineered.

The surface condenser, feed water heaters, and exchanger shown above are part of a Lummus system installed early in 1944 in the Gorge Power Station of Ohio Edison Company, Akron. Operating records for the intervening years bespeak sound design and fabrication.

The condenser (effective surface of 32,600 sq. ft. to condense 350,000 pounds of steam per hour) has operated over this period without overhauling of shut-down magnitude. Equipped with a deaerating-type hotwell of Lummus design, deaeration has been constant over loads varying from 25% to normal capability of 45,000 kw. Condensate has been tested every shift for oxygen content. Throughout the seven-year run, readings have fallen consistently within what our customers' engineers consider "zero"—a maximum of .005 cc. per liter!

Feed water heaters and exchanger are able running-mates. Heaters were designed for a 7° terminal difference. Routine tests show performance equal to or better than requirements. The two high-pressure heaters to the left employ the Lummus Patented Multilok Closure for channel and floating heads. In seven years of operation, all maintenance has been negligible. Gasket replacement for the Multilok Closure requires only 2-2½ hours on the average for complete turnaround time.

For heat exchanger equipment that gives near-perfect performance, see that *your* next job goes to Lummus. There's an office near you for prompt service.

THE LUMMUS COMPANY

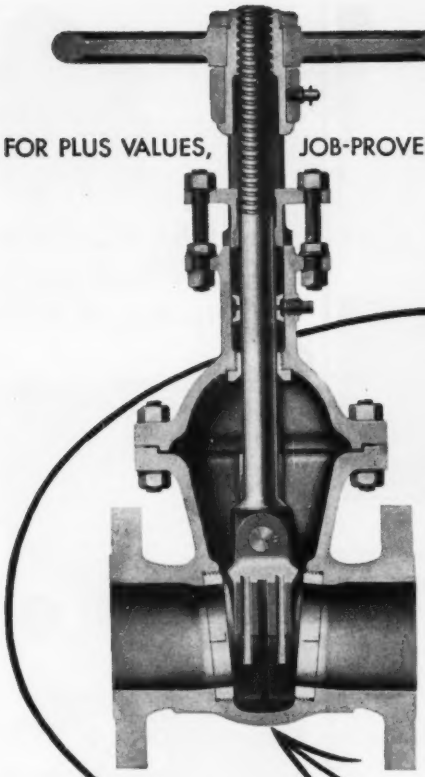
HEAT EXCHANGER DIVISION • 385 MADISON AVENUE, NEW YORK 17, N.Y.

Atlanta • Boston • Chicago • Rock Island • Cincinnati • Detroit • Ft. Worth • Houston • Tucson • Salt Lake City • Minneapolis • Pittsburgh • Rochester • Albany • St. Louis • San Francisco • Wayne (Phila.) • Athens • Buenos Aires • Honolulu • London • Manila • Toronto • Paris • Rome • San Juan, P. R. • Mexico City

Steam Surface Condensers • Evaporators • Extraction Bleeder Heaters • Steam Jet Air Ejectors • Steam Jet Refrigeration • Barometric Condensers • Heat Exchangers for Process and Industrial Use • Process Condensers • Pipe Line Coolers.

FOR PLUS VALUES, JOB-PROVED AGAIN AND AGAIN

DARLING VALVES



DARLING
SLOTTED WEDGE
CAST STEEL GATE VALVE

Darling Valves for every need

Darling gate valves are made in a wide range of sizes, types and constructions for all kinds of normal and unusual service . . . and for pressures up to 1500 pounds. In addition to the slotted *wedge types, there are solid wedge taper seat valves and the famous Darling fully revolving, double disc, parallel seat gate valves for virtually any service.*

It's so easy to cinch improved valve performance!

LET'S skip the details on sound metal, high strength and precision—the things you'd naturally expect in *any* quality gate valve. Instead let's consider . . .

SLOTTED WEDGE . . . *Allows compression of the wedge. Compensates for valve body expansion or contraction due to temperature changes. Thus tight closing and easy opening are assured, with far less wear and tear on wedge faces and seats.*

DOUBLE-GROOVED WEDGE . . . *Double grooves, with corresponding twin ribs in valve body, provide twice the usual bearing area for more positive, more lasting alignment. This eliminates wedge canting due to line pressure, preventing damage to downstream seat.*

Take a moment to weigh the lasting, money-saving advantage of these features. Prove to *yourself* how easy it is to profit by longer valve life, less maintenance and less trouble.

WRITE FOR BULLETIN

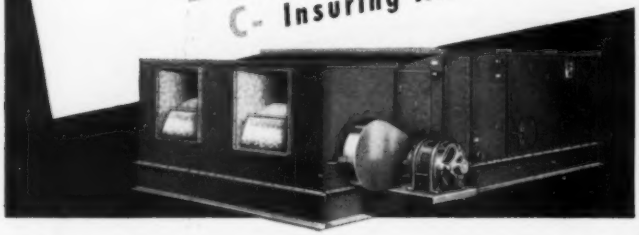
Simply outline your service requirements, including pertinent data, or ask for bulletin on cast steel valves.

DARLING VALVE & MANUFACTURING CO.

Williamsport 8, Pa.

One HEAVY-DUTY CLARAGE Unit for:

A- Controlling Temperature
B- Controlling Humidity
C- Insuring Air Cleanliness



Use Clarage Capillary Air Conditioners where *maximum air cleanliness plus accurate control of temperature and humidity* are vital to production, uniformity of product, health or safety.

These Capillary Conditioners are completely assembled units, including a capillary cleaning section, pump, heating coils, fans, drive and motor. Built in seven sizes — 1,800 to 20,000 cubic feet of air per minute, either vertical or horizontal units.

There are excellent reasons for preferring this modern equipment: (1) *Inexpensive to install* — no costly building alterations required; (2) *Everything in one "package"* — no parts to assemble; (3) *Proper performance* assured by factory tests; (4) *Low first and operating costs* — the result of shrewd, advanced engineering.

CAPILLARY AIR WASHERS
4,400 to 132,000 CFM

Clarage Capillary Air Washers are widely used where you need air cleanliness only (temperature and humidity control not desired), or they may serve as the cleaning units in complete air conditioning central systems. Built in 5 height and 11 width sizes.

All Clarage equipment is HEAVY-DUTY; *fully equal to severest industrial requirements.*

We Also Make: **Complete Line of Industrial Fans . . . Unit Heaters . . . Air Conditioning Equipment . . . Mechanical Draft Apparatus**

CLARAGE FAN COMPANY – *Kalamazoo, Michigan*

CLARAGE

—HEADQUARTERS for Air Handling and Conditioning Equipment

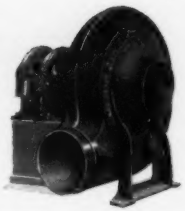
SEE OUR CATALOG IN SWEET'S

It pays to direct fan inquiries our way . . . phone Clarage office in your city, or write us at Kalamazoo.

Application Engineering Offices in All Principal Cities

Capacities to 4000 CFM

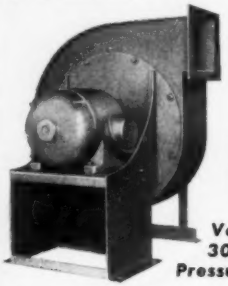
Pressures to 20"



THREE Economy Answers to Industrial Air Handling Problems

1

TYPE CI EXHAUSTERS are built to the *same exacting standards* as the largest Clarage equipment; *heavy-duty* in every sense of the word! Widely used for removing excess heat, smoke, odors from manufacturing operations . . . in pneumatic conveying . . . supplying air to oil burners, as over-fire fans, etc. Regularly furnished with corrosion-resisting cast iron housings, or in any special construction your special needs demand.



2

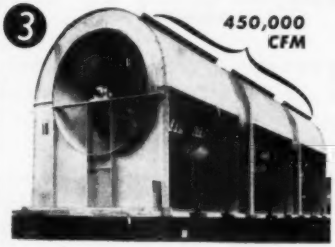
Type O Blowers

Volumes to 30,000 CFM
Pressures to 35"

For *higher pressure*, larger capacity applications . . . supplying air to cupolas, industrial gas and oil burners, etc. Fan housings and wheels of heavy steel plate "take in stride" toughest operating conditions. Clarage Type O blowers are built in 19 sizes; operate at speeds *most economical* for direct motor or turbine drive.

3

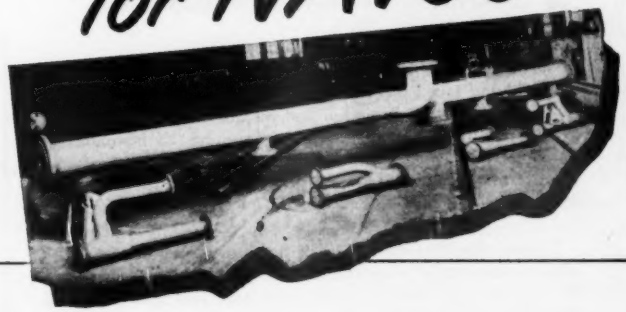
450,000 CFM



CLARAGE BUILDS equipment *big enough for ANY air handling requirement.* Example: these three Type W Fans recently shipped to a steel plant, and now installed in a large building where gas engines generate electricity. They dilute escaping toxic gas fumes, thus providing safe air for workers. Each fan delivers 150,000 cubic feet of air per minute; must operate continuously. Their *heavy-duty* qualities insure uninterrupted service on this essential job.

CLARAGE FAN COMPANY, Kalamazoo, Mich.

No job is too unusual for NAVCO



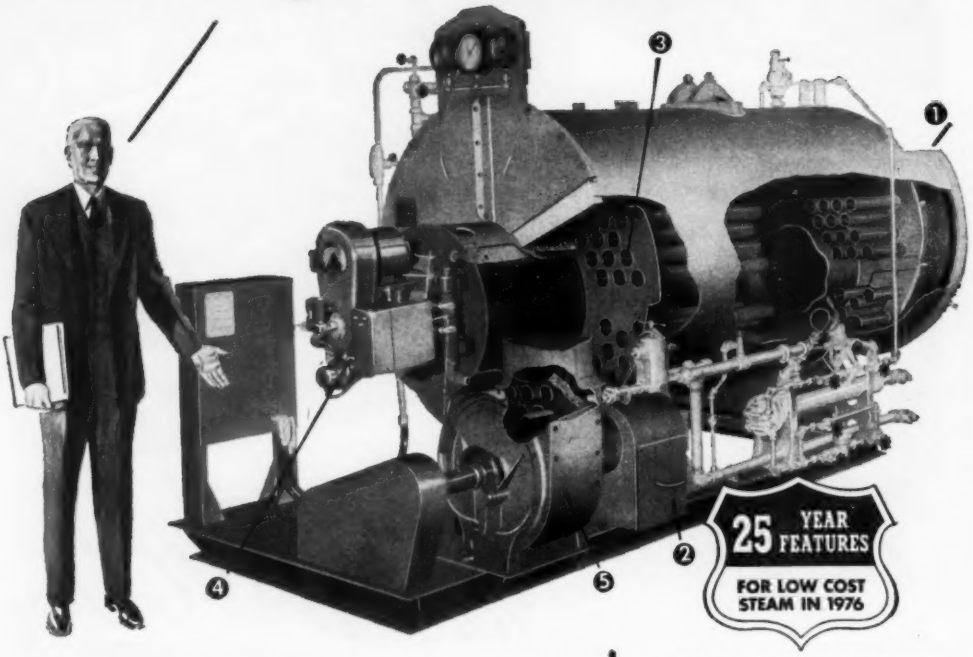
Whether you require a simple pipe bend or a complicated prefabricated assembly Navco can help you. As shown above, Navco Shops are equipped to handle Chrome Moly, Stainless, Carbon Steel and Copper, in addition to any of the many other Ferrous and Non-Ferrous materials.

NAVCO PIPING

NATIONAL VALVE & MANUFACTURING COMPANY • PITTSBURGH, PA.

NEW YORK • CHICAGO • CLEVELAND • BOSTON • ATLANTA • TULSA • BUFFALO • CINCINNATI

I asked a hundred questions ...and bought **PREFERRED!**



A steam generator is a big investment for me. So I looked over the field and asked plenty of questions. "What is the first cost? What about fuel consumption and maintenance over the years? How often would I have to clean the tubes to maintain the guaranteed efficiency? What would be the full cost per year over the life of the unit?" These were only the starters. A hundred answers later I bought a Preferred Unit Steam Generator.

I found that Preferred built their unit to deliver top efficiency with a minimum of maintenance *for the life of the boiler.* Their 25-year features* helped convince me that Preferred has a big edge over the field . . . that it's the *most economical* steam generator on every count.

* Each distinctive feature of the Preferred Unit Steam Generator is designed to give efficient, economical service for an average of 25 years, with proper care and maintenance. You benefit by better performance . . . longer life . . . lower boiler costs.

1. Anti-stress deck for tube sheet protection.

2. Special precipitator developed by Preferred as aid to safe, clean operation.

3. Staggered tube construction—minimizes possibility of tube pitting, even at low firing rates.

4. 4700 rpm horizontal rotary oil burner with patented VOLUVALVE fuel regulation—designed and manufactured by Preferred—assures fully automatic operation even with No. 6 oil.

5. Self-cleaning induced draft fan with air cooled shaft and bearings—assures long life.

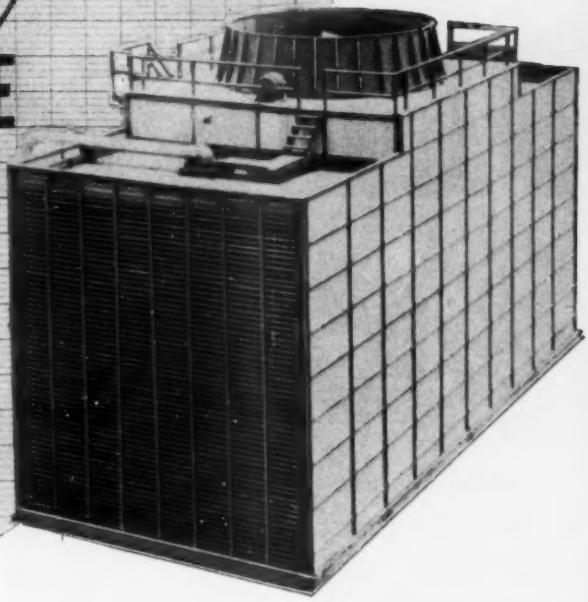
6. Down-draft gas travel for 80% thermal efficiency—proved and guaranteed.

7. Dual purging cycles for positive elimination of gas stratification.

8. 4-pass, high velocity, gas travel—minimizes tube cleaning maintenance by self-cleaning action.

PREFERRED UTILITIES MANUFACTURING CORP.
1860 BROADWAY, NEW YORK 23, N. Y.

PEAK PERFORMANCE DEMANDS MARLEY DOUBLE-FLOW



As the production curve ascends, Marley DOUBLE-FLOW owners increasingly will know the double satisfaction of a good investment and a problem solved.

Marley patented DOUBLE-FLOW design long has been accepted as the standard for functional efficiency. *Now* the exclusive DOUBLE-FLOW features that make for every-minute operation are of utmost importance.

Only DOUBLE-FLOW OPEN DISTRIBUTION permits cleaning in minutes instead of hours and without complete shutdown. Only DOUBLE-FLOW design reveals tower operating condition at a glance. And Marley MECHANICAL EQUIPMENT, engineered for cooling tower service exclusively, is a final assurance of uninterrupted service.

DOUBLE-FLOW has a definite place in your production picture . . . let your nearest Marley Application Engineer explain it without obligation or write for Bulletin DF-50.

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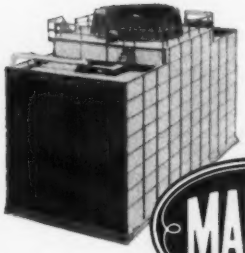

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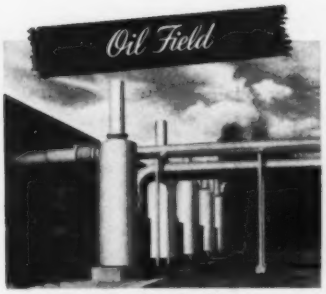
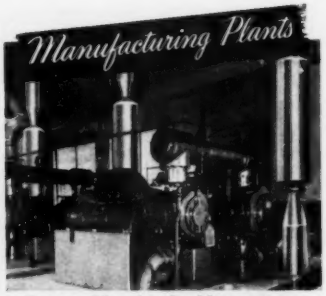


Burgess-Manning Snubbers on gas booster engines at a Louisiana station.

Two Burgess-Manning Exhaust Snubbers installed on this yacht.



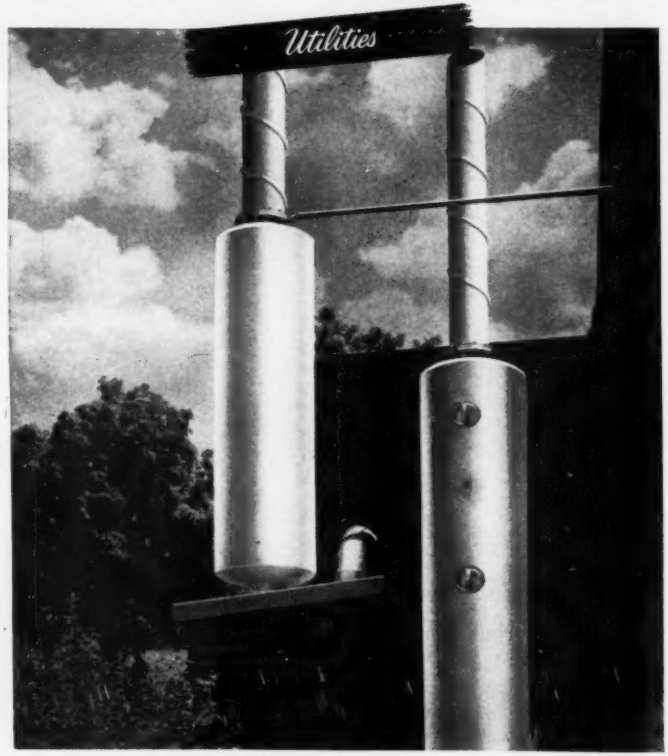
Burgess-Manning Snubbers on compressors at a manufacturing plant.

Reduce Noise

on Engine Exhausts and Compressor Intakes with BURGESS-MANNING SNUBBERS

●

Build Good Will in Plant and Community — Provide Quiet Surroundings... with Burgess-Manning Snubbers



Burgess-Manning Snubbers installed at a Michigan diesel electric power plant.

● Wherever you find an internal combustion engine, compressor, blower, or pump, you will more than likely find a Burgess-Manning Snubber reducing noise . . . building good will for you in your plant and in your community. Burgess-Manning Snubbers smooth the flow of exhaust gases and intake air. High energy "slugs" of exhaust gas are dissipated in successive snubbing stages — the gas reaches the atmosphere in a smooth stream. Incoming pulses of turbulent air to compressors are likewise smoothed to a unidirectional flow. Noise is reduced, vibration is practically eliminated. Metering simplified. Performance of equipment stepped up. Reduce maintenance on engines, compressors, and associated equipment.

For an outstanding solution to your internal combustion engine or compressor noise problem, call in Burgess-Manning engineers, specialists in noise reduction and surge control problems.

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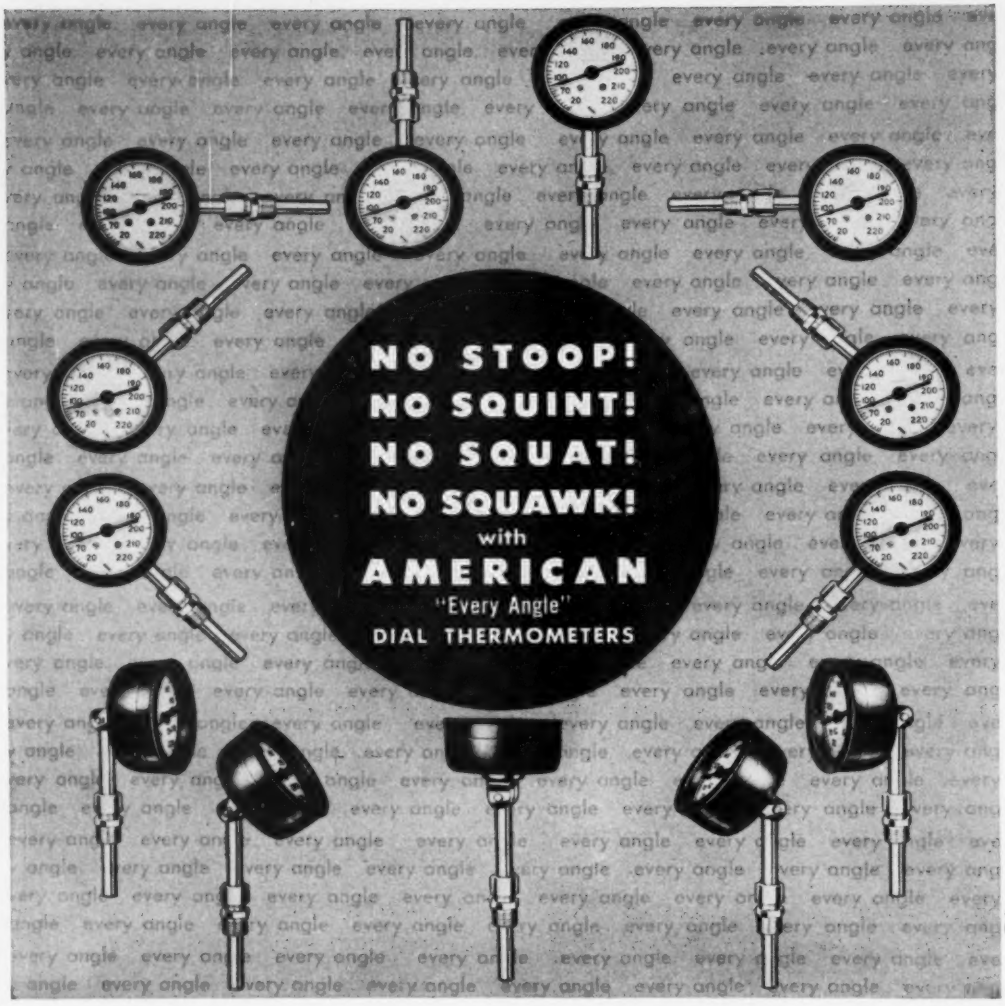

Introduced by American, the "Every Angle" Dial Thermometer completely eliminates *difficult reading positions*. You simply install the "Every Angle" and turn the dial to the angle that is most convenient. What's more, the bold, black numerals on the white face can easily be read—even from a distance.

In two designs, for indoor or outdoor service, the American "Every Angle" is *the only dial thermometer with a balanced movement*. Positional error, inherent in angle-type dial thermometers, is completely eliminated.

For convenient, accurate, and dependable temperature indication in all difficult reading installations, use American "Every Angle" Dial Thermometers. They're time, labor and money savers. Write for Bulletin 101 for complete details.

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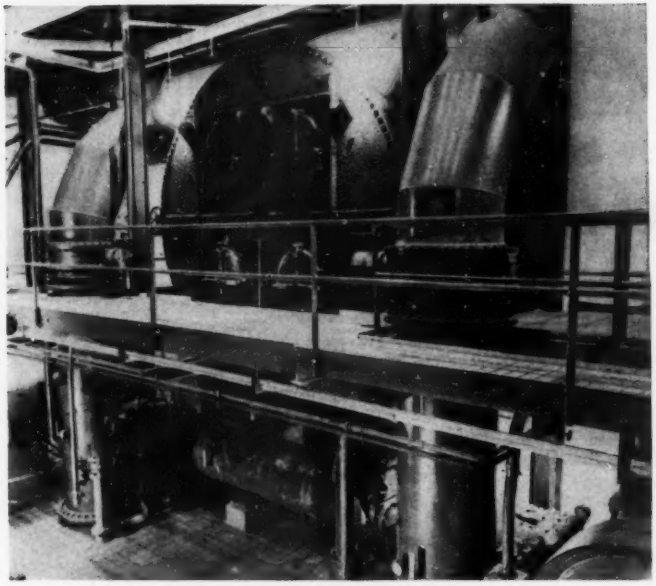
Conserving Condenser Tubing

Tube Conservation Program



A 33,000 sq. ft. divided flow condenser installed in the New Castle, Penna., plant of Penn Power Company. Courtesy Condenser Service & Engineering Co., Inc., Hoboken, N. J.

Operators must be more alert today to extend the life of condenser tubes by carrying out a more careful and more frequent inspection and maintenance program regardless of the higher costs involved.

The factors which are responsible for accelerated corrosion attack should be determined and steps taken to counteract them. Close recording of tube failures should be made. Frequent removal of mud and debris from intake tunnels, screens, water boxes and tubes should not be neglected to prevent foreign matter from entering and doing damage. Chlorination and cleaning should be performed regularly to keep marine growth and slime to a minimum. In some cases, where impingement or erosion are serious, coating the inside of the tubes with a protective material six to eight inches from the inlet end has proved helpful.

Vibration Causes Trouble

Excessive vibration can lead to corrosion fatigue cracking of tubes. Pulsating streams of liquids or gasses striking the tubes at high velocities frequently start tubes vibrating. Vibration of compressors, pumps and adjacent equipment also may start some of the tubes vibrating. These sources of trouble should be checked to prevent such tube failures.

If troubled by air impingement or erosion at the inlet end, flowrites should be installed before the damage becomes serious. A careful study should be made to determine the causes of impingement attack — stopping air leaks in pumps and supply pipes, reducing turbulence at the inlet end, removing silt, venting or installing de-aerator screens in front of the tube sheet if necessary to remove entrained air and other gases.

Study Water Velocity

A check on the velocity of the cooling water may also lead to beneficial changes in operating procedure to protect tubes. Impingement corrosion, caused by exceedingly high water velocity, is universally recognized. However, low velocity has permitted debris, slime and other foreign matter to adhere to tube walls in many instances. When the velocity was increased the condition was corrected except in cases where the foreign matter had gained too much of a foothold.

The March, 1950 Bulletin

A tabulation giving suggestions for keeping records of tube performance, controlling foreign matter, various cleaning methods in use, checking vibration and storage of spare tubes is found in the March, 1950 issue of the Copper Alloy Bulletin. A reprint will gladly be mailed upon request.

In the interest of conserving condenser and heat exchanger tubes, the experience of our Corrosion Laboratory is available to operators of power plants, ships, refineries and process plants. (6451)

Bulletin Reprints Available

Reprints of the Condenser Tube Edition of the Copper Alloy Bulletin will be sent regularly to those who request that their names be added to the mailing list. Copies of some back issues are also available.

Write to Bridgeport Brass Company, 30 Grand Street, Bridgeport 2, Conn., attention Editor Copper Alloy Bulletin.

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Effective Removal of SiO_2

FROM FEEDWATER

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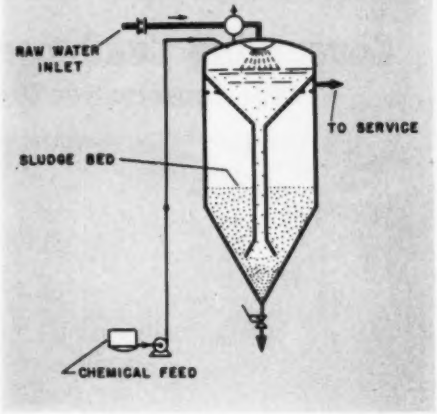
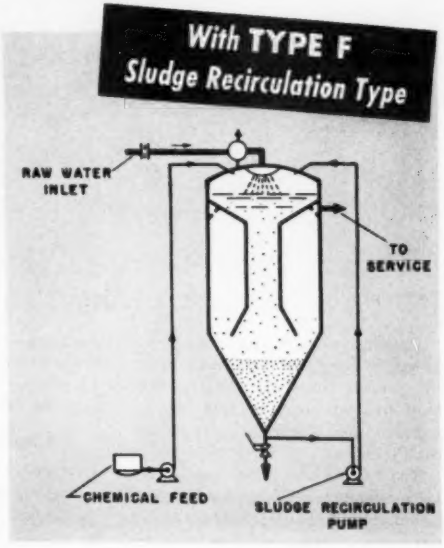
Sludge Contact Type



With TYPE F
Sludge Recirculation Type



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In all Graver hot process softener designs, the exceptionally low rising rate of treated water from the sludge bed to the discharge, due to the special downcomer design pioneered by Graver . . . half the rising rate in other designs . . . provides clearest treated water and least load on filters.

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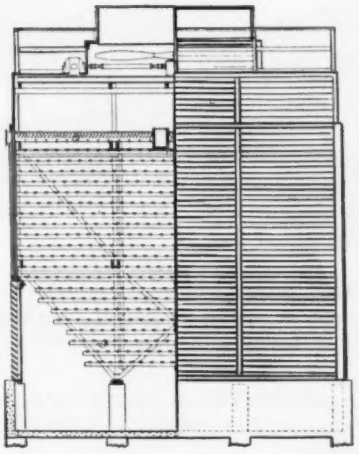

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2. Don't listen to or spread rumors against a race or a religion.
3. Speak up, wherever we are, *against* prejudice. Work for understanding.

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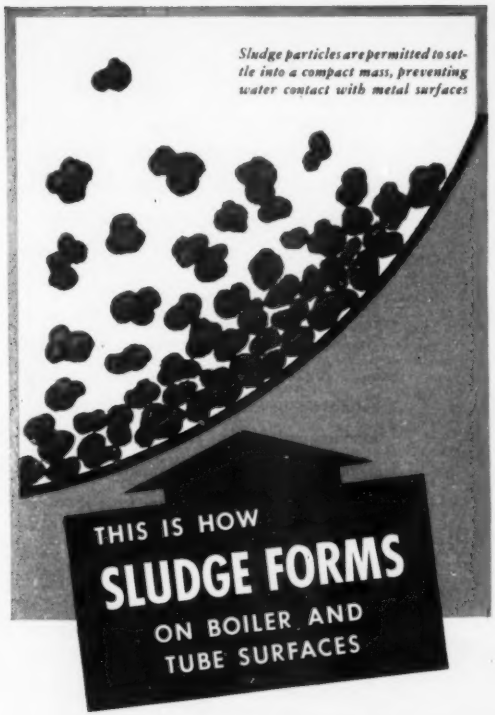
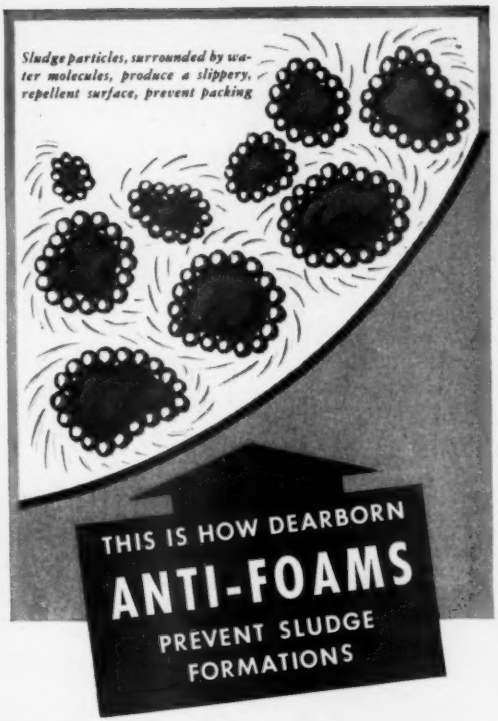

Sludge particles are permitted to settle into a compact mass, preventing water contact with metal surfaces
THIS IS HOW
SLUDGE FORMS
ON BOILER AND
TUBE SURFACES


Sludge particles, surrounded by water molecules, produce a slippery, repellent surface, prevent packing
THIS IS HOW DEARBORN
ANTI-FOAMS
PREVENT SLUDGE
FORMATIONS

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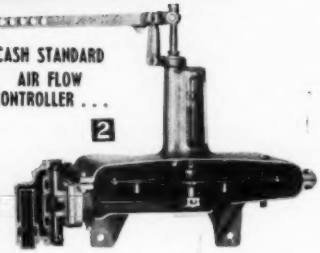

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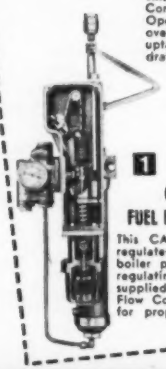
this CASH STANDARD Air Flow Controller meters the air needed for combustion. Install it near its damper. It is not affected by changes in fuel bed resistance or any other variables, because it meters air supply according to the differential pressure through the gas passages of the boiler, doing its part to insure perfect combustion.



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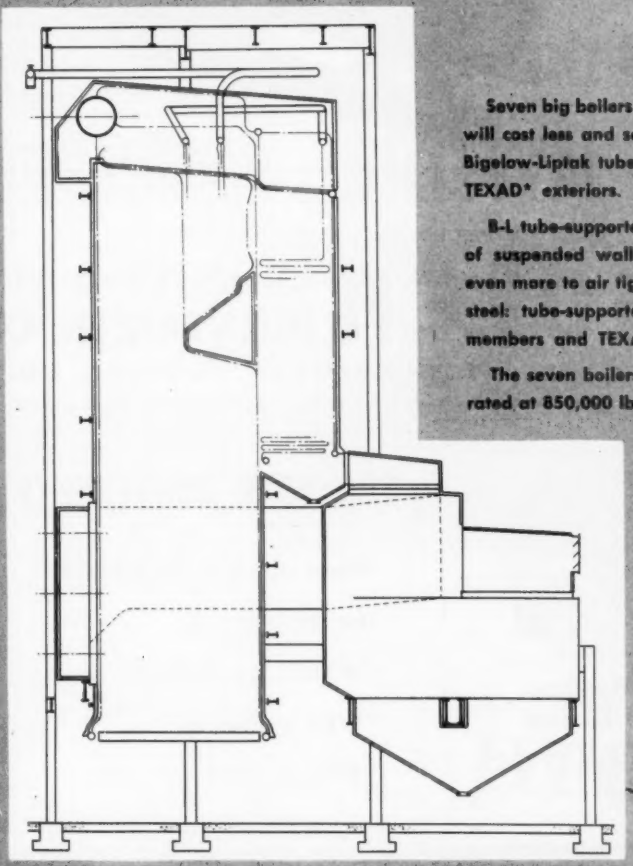

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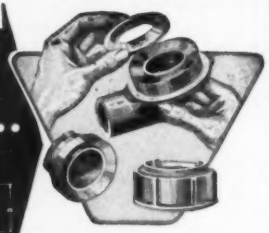

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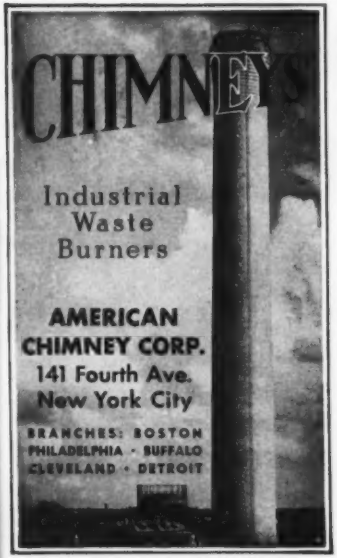

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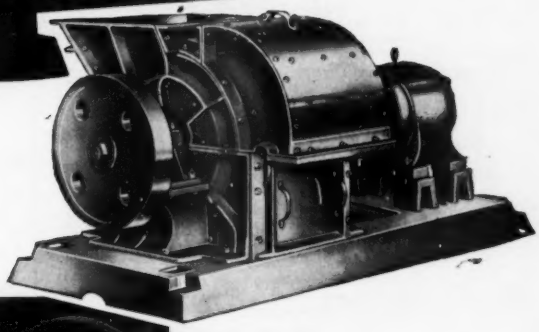

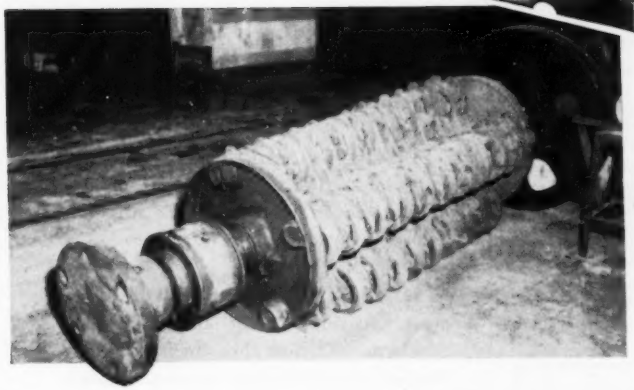

23 Year Old AMERICAN CRUSHER Now Ready for New Career

Far from being ready for retirement, the 23-year-old American Crusher, whose rotor is shown here, was recently overhauled and transferred to its new home at the Arkwright Mine in Morgantown, West Virginia—where it is now prepared to start a new and productive life.

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Since 1927 this mechanical "old faithful" has reduced over 2½ million tons of 6-inch lump to minus ¾ inch screening—at a *total parts-replacement cost of only $.0007 per ton* (including the recent reinstallation costs).

Only such features as the exclusive, patented Shredder Ring—originated and perfected by American—could produce such long-lived, economical performance as shown in this typical case history. When you plan to purchase a coal crusher, plan to investigate the built-to-produce American Rolling Ring Crusher.

WRITE for Bulletin "CRUSHING COAL AT LESS THAN 1¢ PER TON"

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Originators and Manufacturers of Ring Crushers and Pulverizers

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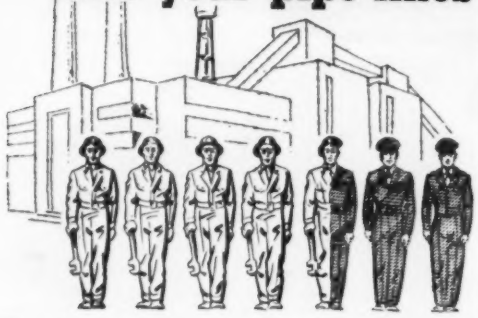

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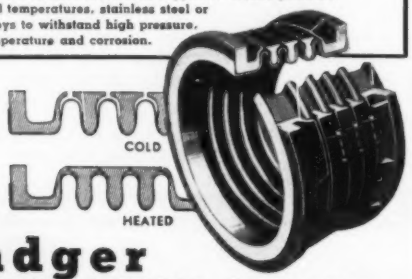
Fabricated from deoxidised copper for normal pressures and temperatures, stainless steel or alloys to withstand high pressure, temperature and corrosion.



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SENIOR FIELD Electrical Engineer to work directly under Assistant Chief Electrical Engineer, to supervise work done by District Electrical Foremen in various camps. Concentrator Electrician etc. Three-year contract, transportation both ways and salary while traveling paid by company. In reply give complete details. P-8880, Power.

WE ARE interested in contacting a man having 15 to 20 years experience in steam and power. If you feel that your experience is sufficiently broad to permit your functioning in a consulting capacity please furnish us with complete information on your background, education and include a recent photograph. We are located in a college town approximately 35,000 population Central Wisconsin. P-8922, Power.

(Continued on page 280)

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Electrical Mechanical Structural

Openings in Ohio and New York offices offering long term employment with good salary for qualified Group Leaders, Designers and Draftsmen experienced in one or more of the following phases of industrial plant design:

Electrical Power, lighting layouts and electrical controls.

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Please submit complete resume stating experience, education, salary required and availability date.

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The Ferguson Building
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Salary open. Furnish complete experience data, samples of workmanship, recent photograph, references, earliest date could report for work, with reply. Only maturely experienced men wanted.

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CHIEF STATIONARY ENGINEER REQUIRED FOR MONTREAL EAST OIL REFINERY

To take charge of modern steam plant and associated equipment. Should be thoroughly experienced in steam plant operation and maintenance, capable of directing staff and co-operating with engineering personnel. Applicants now holding Province of Quebec Chief Stationary Engineman's Certificate Grade AB preferred, but applications will also be considered from those holding 2nd Class Grade AB certificates and others who feel they could qualify for this position. Salary open. Applications will be held strictly confidential and should give full details as to personal and occupational qualifications.

P8529 POWER
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Qualified to prepare engineering studies, detailed mechanical designs, specifications and estimates for industrial and public utility steam power plants.

Salaried position commensurate with experience; location in Boston. In reply please state educational qualifications, work experience, and salary desired. Present employers will not be contacted before personal interview.

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OPPORTUNITIES OPEN for sales representative with a large national manufacturer of power plant feedwater treatment and allied chemical lines for industrial plants. Established territories open. Mechanical or Chemical Engineering degree from accredited college or university required. Under 35 years of age, three years' experience in sales, engineering, production or related fields. Write fully, giving business history and salary requirements. All replies confidential. RW-8261, Power.

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INGERSOLL RAND • Model 75M (315 CFM)
220 Volt—3 Phase—60 Cycle, or equivalent
NEWTOWN IRON & STEEL CORP.
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NEW— —SURPLUS
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Motors, Controls, Transformers,
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Union Iron Works, 533 h.p. horizontal tubular Boiler, 3 drum, A.S.M.E. Code, 1000 steam pressure, complete with the following: Superheater, boiler meter, soot blowers, electric eye, coal pulverizer, steel coal bin and bucket conveyor; new 1930, condition good. Sacrifice for quick sale.
Surplus & Salvage Co., Inc.
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2—ELLIOT TURBINE GENERATOR SETS
Gen.: 250 KVA 3/60/208V .8PF/1200 R.P.M. Turbo; Noe. cond. 200 lbs. PR. 100° Super heat. 5 lbs. Exh. 5000/1200 R.P.M. 294 H.P.
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ALBERT HELLER CO. Hyacinth 3-0800
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1—200 H.P. B&W Straight Tube Boiler and type E STOKER, in excellent condition.
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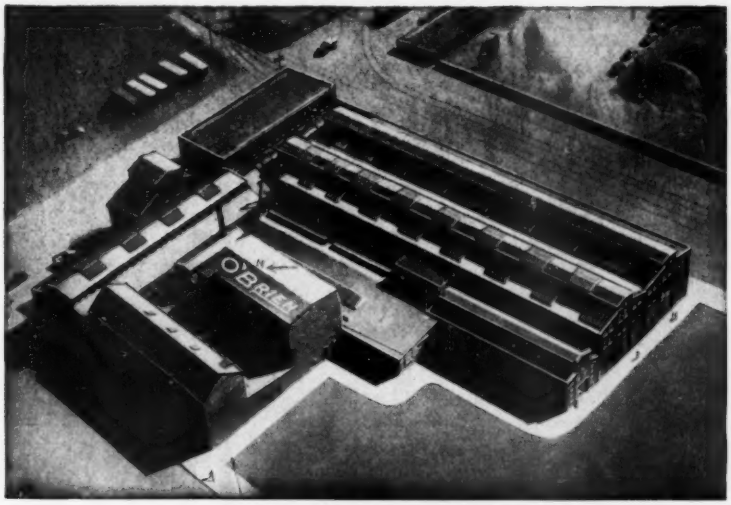

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Q.	HP	Make	Type	Volts	Speed
1	1200	Cr. Wh.	Sl. Rg.	2300	257
1	650	G.E.	TS(Syn)	440	360
2	600	West.	Syn.	440	257
1	400	West.	CW	440	514
1	350	West.	CW	440	600
1	315	G.E.	Syn.	2200	720
1	250	West.	CS	2200 (25 cyc)	375
1	250	West.	CS	2300	1200
2	200	E.M.	Syn.	4160	600
1	200	West.	MW	440	600
1	150	Ideal	Syn.	220	1200
1	150	El. Mch.	Syn.	220	900
1	125	Cent.	SC	440	1800
2	100	West.	CS	220	1800
1	100	Cent.	SC	220	1200
2	75	Cent.	SC	440	1200
1	75	West.	CW	440	1200
1	60	Ideal	SC	220	1200
1	60	West.	C.W.	440	720
1	50	West.	C.W.	220	900
1	50	G.E.	I.M.	440	600
2	50	Cent.	SC	220	1200
1	40	G.E.	MT-536	440	900
1	30	G.E.	MT-532	440	900
2	25	G.E.	MT-332	440	900
1	100	West.	SK183	230V. D.C.	400/1200
1	50	Cr. Wh.	CMC	230V. D.C.	300/1200

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1—750 KVA General Electric Extraction Turbo Generator, 3/60/2300 volt, 250 psi, 80 pound and 16 pound extraction. Surface condenser, switchboard. New 1940.

1—390 HP and 2—360 HP Springfield Sectional Header 300 psi, water tube boilers, with superheaters, side water wall construction, including Combustion Type E Stokers. Green Fuel economizer, Feedwater heaters, Coal unloading and conveying equipment, Boiler feed pumps, etc.

Now in operation, available April 1st, 1951.

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3—12,000 CFM Ingersoll Rand Turbo Compressors 3.25# pressure, 250 HP 3/60/440/3600 rpm motor drive.

1—3000CFM Sullivan Angle Compound 100 psi, 500 HP Syn. M.D. 3/60/2300

1—1050CFM Worthington, 18x11x14 100 psi, 257 RPM, Belted

1—1050CFM Ingersoll-Rand ES-1, 17¾x13, 50 psi, 275 RPM, V-belt

1—880 Worthington 17x10½x12 synchronous Motor drive 150 HP 3/60/440

1—734CFM Sullivan Angle Class W13, Single Stage 13x13x8, 60 Lb., 300 RPM, v-belt, 100 HP

2—528 CFM Chicago NSB, 100 Lb., 285 RPM, V-belt, 14x12

2—368CFM Ingersoll ER-1, 285 RPM, 100 psi., 50 HP direct gear, M.D., 3/60/220

1—277CFM Chicago PB4 Air Cooled 50 HP V-Belt Motor Drive

1—245CFM IR-10x10 ER-1, 125 lb.

1—215CFM Penna. 3A—10x8, 50 Lb.

2—173CFM Ingersoll ER-1, 9x8, 300 RPM, 100 LB., V-belt

DIESEL GENERATORS

1—2500KVA General Motors, complete plant, 3/60/2300 with 2300 to 230/460 transformers, cooling system, starting equipment, switchboard, can demonstrate on foundations. Immediately available.

1—225 KVA Gen. Motors Twin 6-71, 3/60/440. NEW 1941

200KW Fairbanks Morse, 250v., D.C. 720 rpm 8 cylinder, 4 cycle, Complete—1940

200KW G.E.-Fairbanks Morse, 720 rpm, 3/60/220/440—8 cyl., 4 cycle—1940

200KVA Cummins LI 400 3/60/440/900 rpm—Radiator—Sw. Bd.

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56KVA G.E.-Climax Gasoline Portable, 3/60/220/1200 rpm

40KVA NEW Chrysler 3/60/220—2 units

30KW Buda, 3/60/220/1200 rpm

20KW Le Roi Gasoline—1/60/110-220 volt

TURBO-GENERATORS

1—625KW West. 3/60/2300/3600 RPM, 125 Lb. psi, 6 Lb. B.P.

1—600KW G.E. Extraction 360/2300/250 psi., 80 lb. & 16 lb. extraction. Surface Condenser new 1940.

1—400KW West. 3/60/480, 150 psi., 10 Lb. B.P

1—300KW Elliott (New 1941) 250 Volt D.C., 150 Lb. I.S.P., 20 Lb. B.P.

1—300KW G.E. 3/60/2300/100 p.s.i. 0-15 Lb. B.P.

1—160KW West. 3/60/220/3600 RPM, 125 Lb. psi., 10 Lb. B.P.

1—160KW Ridgeway 4 Valve Steam Engine Generator, 3/60/220

1—100KW NEW 3/60/220 150/200 psi. 0/30 Lb. B.P.

1—35KW G.E. 125 volt D.C., 3600 RPM

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1—14" Worthington LAS, double suction, 5000 gpm, 112 foot, 200 HP, 3/60/440/900 rpm motor.

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40 HP Reliance Variable Voltage Drives, each Consisting of:
1—40 KW 250 Volt Induction M-G Set, with two auxiliary 5 KW generators and exciter.
1—40 HP 400/1500 RPM, Frame 385T, 230 Volt, DC Motor.
With full magnetic control providing leg forward, leg reverse, run, fast, slow, and stop, and motor operated field rheostat.

SLIP RING MOTORS—3 Ph., 60 Cy.

Qn.	HP	Speed	Volts	Make	Type
6	7½	810	550	G.E.	MTC-5201
2	10	1140	410	West.	HF-7A
3	10	570	220	G.E.	HI-11
2	11‡	820	550	G.E.	FTC-5008
2	15	1160	440	West.	CW-464C
2	15	570	220	West.	CW-646
1	18	680	440	West.	MW-316
1	20	860	440	West.	CW-638
1	25	1130	550	G.E.	MT-323
2	25	360	220	Wagner	BR
2	25	720	440	Wagner	22VBR
1	30	865	440	West.	CW-646
1	30	350	440	G.E.	MT-332
1	30	675	440	G.E.	MT-336
2	35	690	440	F-M	HV-H16A
2	40	865	2200	Al.Ch.	ARY-223C
1	40	560	440	G.E.	MT-346
2	50	1150	440	G.E.	M-336
1	50	860	440	West.	HF-12A
1	50	570	440	G.E.	MT-852
1	52‡	550	220	G.E.	IQC-5013***
1	60	685	440	West.	CW-758
1	60	570	550	G.E.	MTC-5546
1	60	345	550	West.	CW-938
1	80‡	575	440	G.E.	MTC-5352
2	125	430	440	G.E.	IL-16
2	150	1750	440	G.E.	MTP-549
1	175	505	550	West.	CW-1002
1	200	495	2200	G.E.	IM-17A
1	250	600	2300†	G.E.	IM-17
3	300	900	140	G.E.	IM-17
2	300	880	2200	G.E.	IM-17A
4	350	1775	2300	G.E.	IM-E15A
2	350	880	2200	G.E.	IM-17A
1	400	505	550	West.	CW
1	600	1770	440	G.E.	IM-E15C
1	650**	360	440	G.E.	MT-442Y
1	700	735	4/0011‡	West	CW

220 volt motors can be reconnected for 440 volts.
‡Intermittent rating. ***2 phase.
**New. ‡‡25 cycle.
†Also 440 or 550 volts. *Also 440 or 2300 volts

A.C. GENERATORS — NEW

3 Phase, 60 Cycle, 0.8 P.F., Two Bearing, with Damper Winding & Direct Connected Exciter.

Qn.	KVA	RPM	Make	Volts
4	18.7	1800	Columbia	240/120
4	18.7	1800	Columbia	208/120

230 VOLT CONST. SPEED D.C. MOTORS

Qn.	HP	Speed	Make	Type
10	3	850	Reliance	Y-23T
25	3½	850	West.	SK-30
1	7½	1150	G.E.	CDM-65
3	7½	850	G.E.	CD-75
10	10**	1750	Kimble	BA-324
5	10**	1150	Al.Ch.	FB-80
2	10	850	West.	SK-83
10	13½**	600	West.	SK-93
3	15	1750	G.E.	CD-75
5	15	850	West.	SK-90
1	20	1750	L.A.	ONA-L851
1	20**	1450	G.E.	CDM-83
1	20	1750/1310	West.	SK-83
2	20	1150	G.E.	RC-30
1	20**	1450	G.E.	CDM-38
11	20	750	West.	SK-110L
17	25	825	West.	SK-120
1	30	1100	G.E.	RC-13
1	40	1700	West.	SK-103
1	40	750	G.E.	RC-34
1	50	750	West.	SK-150
1	50	650	G.E.	RC-16
1	60	1750/1310	West.	SK-143
1	150	700	Al.Ch.	
2	200	1150	G.E.	RC-38
1	250	1150	C.W.	CMC-101A

230 VOLT ADJ. SPEED D. C. MOTORS

Qn.	HP	Speed	Make	Type
6	5/7½	600/1800	G.E.	RA-30
1	10	400/1600	Reliance	T-92T
1	12½	230/340	West.	SK-130
10	12½**	600	West.	SK-93
1	15	600/1200	West.	SK-100L
1	20	500/1500	G.E.	RF-11
1	20/25	100/1200	West.	SK-153
1	25	400/1600	G.E.	RF-13
1	25	500/1500	G.E.	RF-12
1	25/29	200/1200	G.E.	RF-12
1	30	400/1200	West	SK-163
1	30/40**	400/1600	G.E.	CD-1236
1	35	500/1500	West.	SK-143
1	45/50	400/1200	Reliance	T-4611
1	75	500/1500	Cr.Wh.	CCM
1	75	575/750	Cr.Wh.	CMC-125M
3	100	225/900	G.E.	MPC-A
5	100	400/1200	Al.Ch.	
1	100	330/960	West.	SK-200
1	125	450/1000	West.	SK-190
1	175	250/500	West.	SK-220
2	375	350/500	G.E.	MPC

Above Items Represent a Partial Listing Only. Your Inquiries Will Receive Our Prompt Attention. All Equipment is Located in Our Cleveland Warehouse. We have Controls for Most Items Listed.

SQUIRREL CAGE MOTORS—3 Ph., 60 Cy.

Totally Enclosed Fan Cooled, Ball Bearing

Qn.	HP	RPM	Volts	Make	Type
2	5	1750	440	L.A.	JA-254
10	5	1730	440	G.E.	K-254
5	7.5	1740	440	G.E.	K-284
1	10	3480	440	West.	CS-324
1	10	1140	440	Wagner	CPE-326
1	15	1745	440	West.	CS-326
1	15	1175	440	L.A.	JA-365
1	20	1760	220	G.E.	K-364
1	25	1760	220	G.E.	K-365
1	25	1200	550	G.E.	K-405
1	25	1170	220	L.A.	JX-405
1	25	705	440	West.	CS-W504
1	40	3565	440	G.E.	KF-4058

SPLASHPROOF, BALL BEARING

Qn.	HP	RPM	Volts	Make	Type
23	5	1750	440	L.A.	FS-254
1	5	1735	220	G.E.	K-254
1	5	1160	440	L.A.	FX-284
1	10	3480	440	G.E.	K-284
1	15	1175	440	L.A.	JA-365
4	15	1150	440	L.A.	FX-365
2	40	1175	220	G.E.	K-445
2	50	1760	440	L.A.	FX-445A
5	50	1160	220	G.E.	K-504
1	150	1775	440	L.A.	FX-1168
1	150	880	440	L.A.	FX-1368
1	150	700	440	G.E.	KF-6335

OPEN TYPE MOTORS

Qn.	HP	Speed	Volts	Make	Type
1	15	3485	220	Reliance	AA-B3247
5	15**	1735	440	Century	8C326
1	15	1200	220	G.E.	KT-502
1	15	900	220	G.E.	FTR-512
1	20**	3475	220	West.	CS-326
8	20**	1750	440	Wagner	RPL-364
1	20	1750	220	West.	CS-W364
1	20	1200	220	G.E.	KF-512
2	20	1180	440	West.	CS-464C
2	20	900	220	G.E.	FTR-522
1	25	1800	220	G.E.	KT-312
8	25**	1740	440	Century	8C-364
1	25	1160	440	West.	CS-467C
1	25	900	220	Howell	SCRB-356***
2	25**	878	440	Master	PR-405
2	25	878	440	G.E.	KT-542
3	30	3570	550	G.E.	K-3648
1	30	1160	440	West.	CS-644
1	30	870	220	West.	CS-846
1	40**	3545	220	G.E.	KF-4048
2	40	1750	440	West.	CS-583C
2	40	900	2300	G.E.	FTR-536
4	50**	1750	440	Wagner	RPS-405
1	50	850	220	West.	CCL
2	60**	1750	440	Ideal	AH-444
2	60	900	440	G.E.	KT-346
1	75	1160	440	West.	CS-662C
4	75	870	220	West.	CS-766A
2	75	885	2300	G.E.	KT-352
1	100	890	220	West.	C
1	100	580	2200	G.E.	IK-15A
2	100	500	2200	West.	CS-930
1	100	495	2200	Al.Ch.	AN
2	125	435	440	Al.Ch.	AR
2	125	400	2300	G.E.	I-17-FR
1	200	580	550‡‡	G.E.	KT-5668
2	200	587	2200	West.	CS-39A
1	400	1165	2200	G.E.	IK-F15B
1	500	1200	140	G.E.	KTP-567
1	700	1800	2300/ 4000	West.	CS-4-39D-42

220 volt motors can be reconnected for 440 volts.
**New. ***2 Phase. ‡‡Reconnectable for 440 volts.

G. E. DYNAMOMETER

Cradle Type, with control and Dial Scale.
(Write for Complete Specifications.)

Qn.	HP	DC Volts	RPM	Type
1	200	250	1200	C

MOTOR GENERATOR SETS

125 and 250 Volts D. C.

(Write for complete Specifications)

KW	Make	RPM	DC Volts	AC Volts
3	Cont.	1750	125	220/440
7.5	West.	1455	125	380/220§
10	West.	1750	125	220/440
10	West.	1450	125	220/440†
10	West.	1150	250	220/440
15**	G.E.	1800	125	220/440
15	G.E.	1755	250	220/440
15	West.	1450	125	220/440§
16	West.	1750	125	2200/440
25	G.E.	1200	125	220/440
30	G.E.	1800	250	220/440
30	Al.Ch.	1750	125	220/440
50	West.	1750	250	220/440
50	G.E.	1720	125	220/240†
75	G.E.*	1200	125	220/240

Note: 3KW, 5KW & 7.5KW, 250V Sets Available.
**New. *Synch. Motor Driven. §50 Cy. †25 Cy.

ELECTRIC GENERATOR & MOTOR CO.

4521 HAMILTON AVE. CLEVELAND 14, OHIO

MOTOR GENERATOR SETS

1—500 KW G.E. Syn. 250 V. 900 RPM
1—300 KW G.E. Syn. 250 V. 1200 RPM
1—200 KW G.E. Syn. 250 V. 1200 RPM
1—200 KW WEST. Syn. 250 V. 1200 RPM
1—200 KW ELLIOTT Syn. 125/250 V. 1200 RPM
1—200 KW RIDGWAY Syn. 250 V. 1200 RPM
1—100 KW G.E. Ind. 250 V. 1200 RPM

ROTARY CONVERTERS

1—500 KW G.E. Syn. 250 V. 1200 RPM HCC, 6 Ph., 60 Cy. Transformers.
2—300 KW G.E. Syn. 250 V. 1200 RPM HCC, 6 Ph., 60 Cy. Transformers.
1—300 KW WEST. Syn. 250 V. 1200 RPM 6 Ph., 60 Cy. Transformers.
1—150 KW G.E. Syn. 250 V. 1200 RPM HCC, 6 Ph., 60 Cy. Transformers.
1—150 KW WEST. Syn. 250 V. 1200 RPM 6 Ph., 60 Cy. Transformers.

ARMATURES

1—500 KW G.E. 250 V. MPC Gen. 900 RPM
1—300 KW G.E. 600 V. HCC Conv. 1200 RPM
1—150 KW G.E. 250 V. MPC Gen. 1200 RPM

WALLACE E. KIRK COMPANY
502 Grant Bldg., Pittsburgh 19, Pa.

FOR SALE

2—NEW—"WHEELER" 8,000 Sq. Ft. SURFACE CONDENSERS arranged for 2-pass operation

4—NEW—"WESTINGHOUSE" Size C-43 (Multi-Stage) AIR EJECTORS—SUITABLE FOR UNITS UP TO 8,000 Sq. Ft.

Attractively priced — Detailed Specifications available upon request.

J. A. DOUGHERTY
P.O. Box 90 Bala-Cynwyd, Pa.
Phone:—Cynwyd 4978

FOR SALE

MODERN 1000 KW Turbo-Generator

In Excellent Condition

Non-Condensing, Steel case 80# back pressure .8 P.F., 3 phase, 60 cycle, 4150/2300 volts, alternating current, complete with accessories, switchboard, oil circuit breaker, and direct connected exciter. Only operated alternately for six years. Ideal for Chemical, Rubber, Petroleum, Textile, Pulp and Paper, and Sugar Refining Industries.

NEWMAN & COMPANY, INC.
6101 Tacony St. Philadelphia 24, Pa.

FOR SALE

G. E. Elec. Induction Motor No. 5283051
Type MT 28-2500-257. Form E
Volts 6600. Cyc. 60-Amps. 202 H.P. 2500
Secondary volts 706. Secondary Amps. 1530
Speed, full load 253 RPM Phase 3
2500 H.P. continuous-40 degree C. Rise
G. E. Elec. Controls:
G. E. Liquid Reostat, Cat. No. 4990236. Size 204 Cr 9291.

H. P. GUION
Dredges
303 W. 42nd St. New York, N. Y.

MODERN AIR COMPRESSORS

6040 Ft. INGERSOLL RAND 60 LB. ELECTRIC.
1—3865 & 1—4486 Ft. NEW CHICAGO PNEUMATIC ELEC. 125 LB. W/MOTOR TO SUIT.
676 Ft. INGERSOLL RAND BELTED
1579 Ft. CHGO. PNEU. DIESEL. 125 LB.
1302 Ft. INGERSOLL RAND PRE-2 ELECTRIC. 100 LB.
2—3800 Ft. SULLIVAN WN4 500 HP—440 & 2300 VOLT.
DARIEN, 60 E. 42nd St., New York 17, N.Y.

LAND can help you meet your Production Schedule with

Guaranteed Electrical Equipment

1 YEAR GUARANTEE

1 to 50 HP
NEW and REBUILT
TEFC—EX. PR.—Drip proof and Splash proof
IN STOCK

SQUIRREL CAGE MOTORS
3 phase

H.P.	Make	Type	Speed
200	G.E.	KT557	1760
200	G.E.	KF-6335	880
150	West.	CS	580
150	G.E.	IK	870
150	Century (3)	SCN	1150
125	Century (7)	SCN	1150
100	Wagner (NEW)	XP	1150
100	G.E.	K-544	1175
100	Century (3)	SCN	1150
100	West.	CS	870
100	Al.Ch.		690
75	West. (2)	CS-654C	1750
75	Cont.	B.B.	1750
75	G.E. (3)	K-505	1175
75	G.E.	IK	900
75	G.E. (3)	KT-352	865
75	West.	CS	720
60	F-M	TEFC (2)	1750
60	Howell	SCR	1800
60	West. (2)	CS-607	880
60	Rel. (2)	AA	875
60	G.E.	KT-346	865
60	G.E.	TEFC(GH)	427
50	G.E.	FTR-523	3600
50	Elliott	196	3450
50	West.	CS	1740
50	West.	XP	1150
50	G.E.	KF-445	1170
50	West.	CS-642C	1160
50	West. (3)	CS	870
50	G.E. (2)	IK	870
50	G.E.	FTR-542	870
50	West.	CS	690
40	G.E.	TEFC(GH)	561

SLIPRING MOTORS
3 phase

H.P.	Make	Type	Speed
600	Cr.Wh.	131AQ	507
500	G.E. (2)	IM	450
500	Ideal		1150
225	Wagner	25 cy.	710
200	G.E. (2)	IM	1170
150	Wagner	31VRN	900
75	West.	CW	1150
75	West.	CW	720
75	G.E.	MT556	900
75	G.E.	IM	690
60	West.	HF	850
60	Al.Ch.		690
50	G.E.	MT-536	1150
50	West.	CW	1150
50	L. A.	OGH	870
50	F-M	BV	600
50	Al.Ch.	ARY	575
50	G.E.	IM	490

SYNCHRONOUS MOTORS

H.P.	Make	Type	Speed
475	West.		720
300	G.E.	ATI	900
260	G.E.	TS	900
250	Ideal	SMN	360
200	Ideal	SMW	257
200	West.	Unused	900
180	G.E.	ATI	900
150	G.E. (2)	TS	1200
150	G.E.	ATI	900
125	G.E.	ATI	900
135	West.	G	1200
135	Ideal		1200
100	Elec.Prods.		1200
55	El.Machry.	BRKT	1200

230 V.D.C. MOTORS

H.P.	Make	Type	Speed
400	A-C		415
200	West.	SK210	575
150	G.E.	MPC	400
125	G.E.	RC-15	1750
100	Al.Ch.		1150
90/45	G.E.	RF-17	950/475
75	Sprague		1000/1500
75	G.E.	RC36	800
75	West. (2)	SK-180	475
75	Cr.Wh.	LT	480/670
75	Cr.Wh.	CMC	375/950
75	E-D	25S	450/1350
75	West. (3)	SK151	250/1000
60	West. (3)	SK-160	680
50	G.E.	RC-12	1750
45/90	G.E.	RF-17	475/1950
50	West. (3)	SK-160	565
50	G.E.	RF-17	250/1000
50	West.	SK	250/1000
40	West.	SK-103	1750
40	Century	DN-454	1740
40	G.E.	RC-31	1700
40	G.E.	RC-32	1100
40	G.E.	RC-34	750
40	G.E. (2)	CD-1441	400/1500
40	Cr.Wh.	CCM	700
40	Rel.	461T	400/1200
35	West.	SK	250/1000
35	West.	SK-120	1150
35	G.E.	RLC	440/800
30	G.E. (8)	CDM-85	2200
30	West.	SK	975
30	Cont.	D-103	850
30	G.E.	RC-33	775
30	West.	SA	500/1500
30	West. (2)	SK-143	575
25	G.E.	RC-15	1750
25	West.	SK-83	1750
25	G.E.	*CDM-77	1750
25	E.D.	10S	1500
25	Rel.	92T	1150
25	West.	SA	500/1500
25	West. (2)	SK-130	600
25	G.E.	RF-14	300/1200

115 V.D.C. MOTORS

H.P.	Make	Type	Speed
300	West.	SK	900
100	Cr.Wh.	CMC	900
100	Cr.Wh.	CFC	1150
40	G.E.	CD-113	850
30	West.	S	690
25	G.E. (2)	CD	1800
25	West.	SK-103	1150
25	Cr.Wh.	CCM	750
25	West.	SA	600/1200
15	E.D.	7½S	650/1230
15	Cr.Wh.	CM	650
10	Al.Ch.		900
10	E.D.	7½S	425/1700

550 V.D.C. MOTORS

H.P.	Make	Type	Speed
765	G.E. (4)	MPC	1045/1350

AC GENERATORS

KW	Make	Type	Speed
180	G.E.	ATB	900
100	G.E.	ATB	360
50	F-M	GG	1200
15	G.E.	ASI	1200

AC GENERATORS
Driven by DC Motors

KVA	Make	D. C. Input	A. C. Output
62½	G.E.	230	240
50	Star	115	120
35	G.E.	230	220
31	Ideal	115	440
31	El. Machry.	230	440
18	G.E. (8)	230	120/240
10	Burke	115	120
7½	Hertner	115	440
6¾	G.E.	230	240
5	El.Spec.	115	110
1¼	Al. Ch.	230	110

600 V.D.C. GENERATORS

KW	Make	Speed
400	G. E. (4)	1200
325	G. E.	1200
30	Burke	1750
20	Reliance	1150

600 V.D.C. BALANCER

200 KW, G.E., MPC, 1200 RPM

GENERATORS
250 V.D.C. Motor Driven

KW	Make	Speed
1000	G. E.	900
500	West.	1200
300	Elliott	1200
250	G. E.	1150
200	G. E.	1200
200	West. Roto-trol	1200
150	West.	900
100	Delco	1200
90	G. E.	600
100	G. E.	700
75	G. E.	1200
50	A. C.	1200
40	Rel.	1750
42	ABC (2)	1200
30	G. E.	1200
25	G. E.	1200

125 V.D.C. Motor Driven

KW	Make	Speed
150	West.	1150
100	West. (2)	900
100	G. E.	1200
100	El. Machry.	1200
50	West. (2)	1150
30	G. E.	1150
30	L. A.	1450
25	El. Machry.	1150

GENERATORS
Low Voltage D.C.

Amp.	Make	Voltage
125	Hobart (8)	7½
1500	Century	24
2000	G. E.	24V
100	G. E.	30
1000	G. E.	33
150	Watton	40
1000 (2)	Chandeysson	40
200	G. E.	42
1500	G. E.	50
1500	Century	60
1500	G. E.	60
1000	G. E.	75

FREQUENCY CHANGERS AND GENERATORS

Size	Make	Output Frequency
150 KW	G. E.	150 cy.
154 KVA	G. E.	150 cy.
50 KW	G. E.	120 cy.
40 KW	G. E.	100 cy.
30 KW	G. E.	90 cy.
15 KW	G. E.	408 cy.
10 KW	G. E.	200/700 cy.
7½ KW	G. E.	408 cy.
3 KW	G. E.	408 cy.

TRANSFORMERS

2—400 KVA Maloney Dry Auto—220 to 440 V. 3 ph.
1—300 KVA, Al. Ch. 3 ph. 4160V/230 V.
1—300 KVA. Pittsburgh, 3 ph. 4160V/230V Secondary.
60—Additional Oil and Insulated Dry-type Transformers in stock, not listed, down to 1 KVA.

STARTERS—A. C.

1—450 H.P. West. magnetic reduced voltage (550 V.) Synch.
1—250 H.P. C-H Bulletin No. 9589 4150V.
1—200 H.P. G.E. CR-7065, 440V.
3—150 H.P. G.E. CR-7061, 220V.
2—100 H.P. C-H 220 V. Synch.
40—C-H and A-B; 2 and 4 speed.

STARTERS—D. C.

1—600 H.P. 230V. West. magnetic.
150—New 230V. D.C. magnetic starters, from 5 H.P. to 75 H.P., C-H, G.E., etc.
40—New 7½ H.P. 230V. magnetic reversing.
1—300 H.P. West. 115V. magnetic.

TRAVELING CRANES

2 Ton Harnischfeger, 26' 8¼" Span

Partial List ONLY

EST. 1910 — L. J. LAND INC. — 41st YEAR

156 GRAND STREET — Phone CAnal 6-6976 — NEW YORK 13, N. Y.

THE HOME OF VALUE AND QUALITY FOR . . .

ELECTRICAL POWER EQUIPMENT

GET A-1 PERFORMANCE
SAVE ON PRICE

HERE'S A WIDE SELECTION FROM OUR GIANT STOCK

SQUIRREL CAGE MOTORS
3 Phase, 60 Cycle, 220 or 440 Volts (*2200 Volts or higher)

H.P.	Make	Type	Speed
750	*G.E.	KT	720
400	*G.E.	K (ExProof)	3600
400	*Al. Ch.	ARWW (ExPr.)	900
350	*Al. Ch. (new)	ARW	3600
300	*Westg.	CS	3600
300	G.E.	IE	1770
300	Al. Ch.	AR	900
250	Westg.	CS	1800
250	L. Allis	1468	1200
200	Al. Ch.	ARZ TEFC	1800
200	*G.E.	IE	1794
150	G.E.	IE	1800
150	Al. Ch.	AZ TEFC	1200
150	Westg.	CS650A	1800
125	*Al. Ch.	AR228	1800
125	G.E. (new)	K6333	900
100	U.S.	CFU vert	1200
100	Burke	EM	1200
100	Westg.	CS	1200
100	G.E.	KT5588	720
75	Westg.	CS761	1800
75	G.E.	K505 (DpPr)	1200
75	*Westg.	CS vert	900
75	Ideal	AA350	720
75	Al. Ch.	AN	720
60	Westg.	CSW445 vt.	1800
60	G.E.	K504U	1200
60	Al. Ch.	AR	514
50	G.E.	KT527	1800
50	U.S.	SCV vert	1800
50	Westg.	CS504	1200
50*	G.E.	KT342	900
40	G.E.	KT323	3600
40	Westg.	CS445	1200
40	G.E.	KT336	880

Hundreds of Smaller Motors

AC SYNCHRONOUS GENERATORS
3 phase, 60 cycle, 220 or 440 volts (*2200 volts or higher)

K.W.	Make	Type	P.F.	Speed
1500	G.E.	ATI	.8	900
1000	*Westg.	503D	.8	900
725	*G.E.	ATI	.8	720
350	*Westg.		.8	300
250	*Al.Ch. (new)		.8	720
150	El. Mach.	EM	.8	720
112.5	*G.E.	ATB	.8	1200
112.5	G.E.	T5	.8	1200
110	Cr. Wh.	103	.8	900
100	G.E.	ATB	.8	900
60	*Fr. Morse	D	.8	300
60	Fr. Morse	B	.8	900
55	G.E.	ATB	.8	1200
50	G.E.	ATB	.8	1200
50	Westg.		.8	1200
50	Cr. Wh.	5086	.8	1200
37.5	Al. Ch.	EA121	.8	1800
30	Roth	126RS	.8	1800

AC SYNCHRONOUS MOTORS
3 phase, 60 cycle, 220 or 440 volts (*2200 volts or higher)

H.P.	Make	Type	P.F.	Speed
750	*Westg.		.8	900
700	*G.E.	ATI	.8	720
450	El. Mach.	Ped	1.0	240
320	*Al. Ch.	Dr. Pf.	1.0	720
250	*Al. Ch.	Dr. Pf.	.8	720
200	El. Mach.	Ped	1.0	450
150	El. Mach.		1.0	900
150	El. Mach.	EM	.8	1200
125	G.E.	T3934B	1.0	1200
125	Cr. Wh.	103-S	1.0	900
100	G.E.	T5934B	.8	1200
100	Cr. Wh.	1038	.8	900
100	G.E.	ATB	.8	900
75	G.E.	ATB	1.0	900
60	G.E.	T5753B	1.0	1200
20	Pyan W.	15VRN		1200
15	Century	ARC305	1.0	1200
4	G.E.	AK (25 cy)		1500

MULTI-SPEED AC MOTORS
3 phase, 60 cycle, 220 or 440 volts

H.P.	Make	Speed
40/20	Lincoln	900/450
7½-2½	Reliance Vert	18/12/9/600
7	G.E.	1800/1200
5	G.E.	18/12/9/600
5-1½	G.E.	18/12/9/600
6	G.E.	1200/500
3½	G.E.	18/12/9/600
3	U.S.	1800/900
2	G.E.	18/12/9/600
2	U.S.	1800/900
1	G.E.	18/12/9/600
½	Wagner	1800/900

SLIP RING MOTORS
3 phase, 60 cycle, 220 or 440 volts (*2200 volts or higher)

H.P.	Make	Type	Speed
2000	*G.E.	MT30	240
1200	*Cr. Wh.		240
650	Westg.	HE	350
500	Westg.	CW	350
400	G.E.	IM	514
300	*G.E.	IM	1900
250	Westg.	CW32B	585
200	G.E.	IM	690
125	G.E.	M6333	900
125	G.E.	M6334	720
100	G.E.	IM	720
100	Westg.	CW	600
75	Star	CS60	900
60	Westg.	CW	900
50	Al. Ch.	ARY	1800
50	G.E.	IM	435
40	Westg.	CW644	900
40	Al. Ch.	ARY323	720
35	Fr. Morse	UAB	1800
30	Westg.	CW	1800
30	G.E.	MT332	1200
25	G.E.	IM	1200
25	Al. Ch.	ARY220	900
20	G.E.	MT512	1200
20	G.E.	IM	720
20	Westg.	CW644	600
15	L. Allis	ON326	1800
15	G.E.	IM	1200
15	Al. Ch.	ARY216	900
15	Ideal	AVE	900
10	Westg.	CW324	1800
7½	Kimble	HA284	1725

SLIP RING MOTORS
Crane and Hoist Type
3/60/220 or 440 volt

H.P.	Make	Type	Speed
75	Westg.	CI756A	600
37	G.E.	HITC TENV	600
30	G.E.	ITC5010	1200
25	Westg.	CI572	900
20	Westg.	CI570	900
15	G.E.	ITC5010	720
11	Westg.	CI484	900
8½	R & M	425A TENV	1200
5	G.E.	MTC5180	1200
3	G.E.	MR254 TENV	1200
3	G.E.	MTC5160	1200
2½	G.E.	MTC5130	1200
2½	Star	AHS27	1200

TURBINE SPECIAL
312 KVA Crocker - Wheeler AC Generator 3/00/240/480 volt, d/c to
375 HP Worthington - Moore Turbine, Single Automatic, non-condensing, 425# PSI, 10# Exh., 100° F SH with Reduction Gear and Accessories.

TRANSFORMERS
3—2000 KVA Maloney, 1 phase 13,200 volts primary 2300/4160 v. secondary
5— 750 KVA Westg.—AIR, 3 ph. 13,800 v. primary 480 v. secondary
1— 750 KVA Westg.—AIR, 3 ph. 13,800 v. primary 2,300 v. secondary
3—250 KVA Allis-Chalmers, 1 ph. 34,500 v. primary 240/480 v. secondary
3—200 KVA Westg., 1 phase 2400/4160 v. primary 120/240/480 v. sec.
3—150 KVA Gen. Elec., 1 phase 33,000 v. primary 240/480 v. secondary

BALANCING SETS
4—34 K.W., 250 v., 270 A., new, Bogue. Type MC1, 125 v. gen. BB comp'd on fab. base, d/c
2—20 K.W., 250 v., 160 A., new, Crocker-Wheeler, Type 15I, 125 v. gen. 3 sl. bearings, close-coupled

MOTOR GENERATOR SETS

K.W.	Make	A.C.	D.C.
500	G.E.	2300	250
450	G.E.	2300	250
400	Westg-GE	2300	250
300	Westg.	2300	250
200	Cr.Wh.	2300	125
150	G.E.	440	250
150	Al.Ch.	220	125
100	G.E.	440	250
75	Al.Ch.	440	250
75	Westg.	2300	110
60	Al.Ch.	2300	110
50	Westg.	220	110
40	Cr.Wh.	220	125
40	Al.Ch.	440	250
30	Cr.Wh.	220	125
25	G.E.	440	250
20	G.E.	440	250
20	G.E.	440	125
10	Cr.Wh.	220	125
10	G.E.	440	250

D.C. to A.C.

100	G.E.	230	250

LOW VOLTAGE M.G. SETS

Amps.	Make	A.C.	D.C.
1500	G.E.	2300	60
1000	Chand.	440	40
1000	G.E.	440	35

DIRECT CURRENT MOTORS 230 Volts

H.P.	Make	Type	Speed
375	Westg.	Ped	650
200	Westg.	SK210	800
200	Reliance	1970T	675
175	G.E.	KLC11	750
100	G.E.	RC34	2500
100	Al. Ch.	E152	575
40	G.E.	CQ2004	600
35	Cr. Wh.	CM351	700
35	Sprague	C	600
30	Westg.	SK120	975
30	Cr. Wh.	CCM	450
30	Westg.	SK93	1750
30	G.E.	RC31B	1150
25	Westg.	SK100L	1100
25	Westg.	SK	900
25	Al. Ch.	E	700
20	Westg.	SK83	1750
20	G.E.	RC	1150
20	Westg.	SK	900
20	G.E.	RC	800
20	G.E.	LC	575
20	G.E.	CQ1827	600
15	Cr. Wh.	BH	1750
15	Westg.	SK63	1750
15	G.E.	RC29	1150

D.C. VARIABLE SPEED MOTORS—230 Volts

H.P.	Make	Type	Speed
325	Westg.	QM	450/900
200	Westg.	SK	400/800
150	Westg.	SK	400/1200
125	Westg.	SK193	450/1000
100	Al. Ch.	E-182	575/1150
100	Westg.	SK	400/1100
100/100	G.E.	MPC	100/300
90	Cr. Wh.	CMC	225/550
75	Westg.	SK	330/450
75	Westg.	SK151	250/1000
40/60	Westg.	SK170	525/1150
60	National		250/1000
35	Westg.	SK143	500/1500
35	G.E.	C	300/800

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CARRIES COMPLETE STOCKS OF:

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125 KW, West. 275 volts DC to 200 HP synchronous motor, 220 or 440 volts 3 phase 60 cycles, direct connected exciter 1200 RPM 3 Pedestal Bearings complete control, factory built, used approx. 1000 hr.

WESTINGHOUSE DYNAMOMETER

225 HP 250 volts DC 300/2000 RPM Cradle Type Control and Dial Scale used approx. 1500 hrs.

ADJUSTABLE SPEED MOTOR

1—30 HP, GE type CD 1337, 230 V, DC, 300/1800 RPM. New.

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1—2000 Amp., West. DA-75, 440/3/60 New 1943—Used 3 Years.

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Outstanding Offers

10000 KW Turbo Generators, Surf. Condens.
1000 KW & 500 KW Non-Cond. Turbines 200#
500 KW & 300 KW Cond. Turbo-Gen. 250#
1000 KW Diesel Sets 720 RPM. Guaranteed
575 KW Diesel Engine Set, Unused
3—1667 KVA Transformers, 12000/2300 v.

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484 HP. Sectional Header 250# 100° SH. in first class condition, New 1930

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DIESEL ELECTRIC POWER

2—1000 KW Elliot (NEW), 2300/4000 V, 3/60 with F-M Model 38D8½.
1—750 KW, G.E. (NEW) 4166/2400 V, 3/60, with G.M. Model 12-567A.
1—500 KW, Westgh. (NEW) 4166/2400 V, 3/60, with G.M. Model 12-567A.
3—300 KW, Westgh., 120/240 V, DC, 3 wire 400 RPM, with Baldwin 6 cyl. Model V.O.
3—300 KW, F-M 2300 V, 3/60, with 300 RPM F-M 6 cyl. Model 32E14. Late Type.
1—Spare Crankshaft F-M, Model 32E14, 6 cyl.

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411 HP 200# ALL NEW TUBES

Can ship in one piece

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2000 KW 2300/3/60 G.E. 450 lb. condensing turbine.
1000 KW 2300/3/60 G.E. 175 lb. operating pressure.
300 KW Westh. 150 lb. non-condensing turbine.
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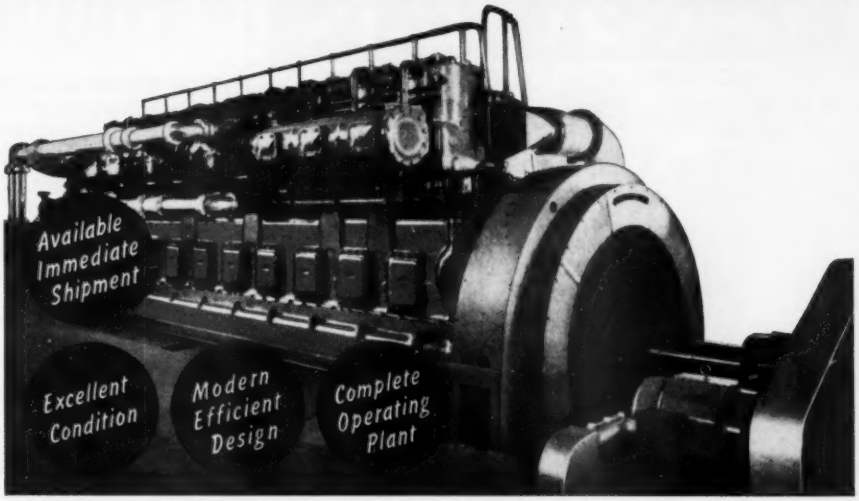

1675 KVA Fairbanks-Morse Diesel Generator Unit

1250 KW 80% P.F. 1675 KVA 50° Fairbanks-Morse alternating current generator 3 phase 60 cycle 2400/600/480 volts, 300 RPM direct connected to

1750 HP Fairbanks-Morse Diesel Engine, 2 cycle, 10 cylinders, Model 33E16, 300 RPM.

The above unit is complete with direct connected exciter, switchgear, starting equipment, heat exchanger, air scavenger, pumps, oil reclaimer, Maxim silencer and inter-connecting piping and fittings as in operation.

STEAM TURBINE GENERATOR UNITS

3 Phase 60 Cycle

5,000 KVA Westinghouse condensing double extraction, 400 lbs. steam pressure, 600° FTT, 125 lb. and 20 lb. extraction, 480 volts, with surface condenser.

2,500 KVA New General Electric condensing extraction, 400/600 lb. steam pressure, 750° FTT, 100-150 lb. extraction, 480/2400/4160 volts, with or without new surface condenser.

1,250 KVA General Electric noncondensing, 150 lbs. steam pressure, 15 lbs. exhaust, 2400 volts.

1,250 KVA Westinghouse condensing extraction, 150-250 lb. steam pressure, 600° FTT, 5-25 lb. extraction, 480 volts, with surface condenser.

625 KVA Westinghouse non-condensing, 150-200 lb. steam pressure, 600° FTT, 25 lb. exhaust, 480 volts.

SPECIAL
NEW 2859 KVA VARIABLE FREQUENCY GENERATORS
3 Phase 60/240 Cycle

3—2000 KW 70% P.F. 2859 KVA New General Electric A.C. generators, 3 phase, 240 cycle, 4150 volts, type ATB-6, 4800 RPM. Can be operated at lower frequencies with proportionate reduced speeds.

UNIFLOW ENGINE GENERATOR UNITS

3 Phase 60 Cycle

750 KVA Allis Chalmers-Ames vertical, 150 lb. steam pressure, 5 lb. exhaust, 2400/4160 volts.

625 KVA General Electric-Skinner horizontal, 150 lb. steam pressure, 5 lb. exhaust, 240 volts.

500 KVA Allis Chalmers-Skinner horizontal, 150 lb. steam pressure, 5 lb. exhaust, 240/480/600 volts.

250 KVA General Electric-Ames vertical, 150 lb. steam pressure, 5 lb. exhaust, 480 volts.

STEAM BOILERS

1,000 HP Springfield water tube boiler, 300 lbs. steam pressure, with Westinghouse underfeed stoker.

600 HP Connelly water tube boiler, 200 lbs. steam pressure, with Taylor underfeed stoker.

350 HP Babcock & Wilcox water tube boiler, 200 lbs. steam pressure, with Greene chain grate stoker.

DIESEL ENGINE GENERATOR UNITS

3 Phase 60 Cycle

1,675 KVA Fairbanks-Morse, 2400/600/480 volts, 300 RPM.

900 KVA Fairbanks-Morse, 2400 volts, 257 RPM.

625 KVA Busch Sulzer, 2400/600/480 volts, 180 RPM.

312 KVA Worthington, 208 volts, 450 RPM.

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ELECTRIC MOTORS & GENERATORS

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M-G SETS

KW	Mfr	Input V	Output V
300	G.E.*	440 AC	275 DC
200	Whse*	2300 AC	275 DC
200	Gen. Elec.*	220/440 AC	125 DC
200	Reliance	2300/440 AC	250 DC
150	Cit. Wh.* e	220/440 AC	250 DC
105	Century b.b.	220/440 AC	70 DC
100	Delco (2)	220/440 AC	125/250 DC
100	Allis Ch.* (3)	2300/440 AC	60 DC
100	Delco b.b.*	2200/440 AC	125/250 DC
100	Gen. Elec.	220/440 AC	125 DC
100	Gen. Elec.	220/440 AC	250 DC
75	Gen. Elec. (2)	220/440 AC	250 DC
75	Gen. Elec. (3)	220/440 AC	125 DC
65	Whse.	220/440 AC	250 DC
60	Gen. Elec.*	220/440 AC	60 DC
50	Allis Ch. (2)	220/440 AC	125/250 DC
50	Gen. Elec.	220/440 AC	250 DC
45	Cr. Wh. b.b.	220/440 AC	125 DC
40	Whse. (2)	220/440 AC	125 DC
40	G.E.	220/440 AC	250 DC
35	Cr. Wh. b.b.	220/440 AC	125 DC
25	G.E.	220/440 AC	48 DC
16	Gen. Elec.	220/440 AC	250 DC

*Syn. motor drive.

D. C. MOTORS

HP	Mfr	Type	Volts	Speed
200	Reliance	1970T	230	575/750
150	Cr. Wh. TEFC	83H	230	900
100	Whse.	8K181	230	450/900
100	Gen. Elec.	C	230	575/1000
100	Gen. Elec.	CD125	230	250
100	Gen. Elec.	RCP-32	230	1700
75	Gen. Elec.	RC	230	1000
75	Allis Ch.	E-149	230	500
75	North'n	KD	230	1750
75	Century NEW	DN	230	850
60	Gen. Elec.	RC 38	230	425/850
60	Cr. Wh.	50H	230	700
60	Reliance b.b.	651T	230	750
60	Gen. Elec.	CD113	230	1150
50	Whse.	8K	230	1750
50	Gen. Elec.	R.C. 14	230	1050
40/60	Whse.	8K160	230	500/1000
40	Gen. Elec.	RC 32	230	1150
40	Cr. Wheeler	KH	230	1750
40	Whse.	8K110L	230	1750
40	Whse. (2)	8K130	230	950
33/50	Gen. Elec.	CD123	230	575/1150
30	Whse.	8K110L	230	1150
25	G.E. b.b. (3)	CD93	230	1150

- EXPLOSION PROOF MOTORS—
- GEARHEAD MOTORS, AC & DC.
- FREQUENCY CHANGERS.
- CIRCUIT BREAKERS, AC & DC.
- SPEED REDUCERS

D. C. GENERATORS

HP	Mfr	Type	Volts	Speed
300	Gen. Elec. 1 brg.	DMC	275	720
200	Reliance	1970T	250	720
105	Century b.b.	1500 amp	70	1200
100	Gen. Elec.	CD	250	1200
100	Gen. Elec.	C	250	750
100	Gen. Elec.	DLC	125/250	675
75	Gen. Elec.	RC	250	1200
75	Allis Ch.	E	250	750
75	Gen. Elec.	RC36	125	1200
65	Whse.	8K160	250	1100
60	Gen. Elec.	RC	250	875
60	Gen. Elec.	CD	250	1450
50	Allis Ch. (2)	EW	125/250	1200
50	Gen. Elec.	R.C. 14	250	1200
50	Cr. Wheeler	50H	250	900
45	Cr. Wh. b.b.	FH	125	1750
40	Whse.	8K	250	1200

A. C. MOTORS—25 CYCLE

HP	Mfr	Type	Volts	Speed
150	Whse.	HF	440	500
60	Allis Ch.	ARY	440	1500
50	Gen. Elec. int.	MTC5337	440	750
50	Gen. Elec.	I-K	440	750

A. C. GENERATORS—60 CYCLE

KVA	Mfr	Type	Volts	Speed
625	Gen. Elec.	ATB	2300	450
625	G.E. 25 cycle	ATB	2300	750
500	Allis Ch.	3 brg.	240/480	360
300	Gen. Elec.	ATB	600	720
275	G.E. 25 cycle	ATI	440	750
250	Whse.	G	2400/480	600
225	Gen. Elec.	ATB	240/480	900
225	Gen. Elec.	ATB	240/480	600
187	Gen. Elec.	ATB	240/480	900
156	Elec. Machy.	3 brg.	240/480	514
150	Gen. Elec.	ATB	240/480	900
125	Gen. Elec.	ATB	240/480	720
125	Gen. Elec.	ATB	240/480	200
100	El. Machy.	B.B.	2484	900

A. C. MOTORS—SLIP RING

3 Phase 60 Cycle 220 or 440 Volts

Qu	HP	Mfr	Type	Speed
1	600	Gen. Elec.	I-M	360
2	500	G.E. New 2300V.	MS74Y	900
1	500	G.E. 3 brg.	I-M	450
1	400	Gen. Elec.	IM	450
1	450	Gen. El. 2200V.	I-P	1200
1	300	G.E. 2200V.	I-M	450
1	300	Gen. Elec. 2300V.	I-M	1800
1	300	G.E. b.b. New	MS66	900
1	250	Allis Ch. 2200V.	ANY	514
1	200	Cr. Wheeler	SR	600
1	200	Gen. Elec. 2300V.	I-M 17A	450
1	200	G.E. 2200V.	I-M-16	600
1	200	Gen. Elec.	I-M	360
1	150	Gen. Elec. 2200V.	I-M-16	600
1	150	G.E. 2200/4000V.	I-M	1200
1	150	Gen. Elec.	I-M-17	450
1	125	Gen. Elec.	I-M-15	720
1	100	G.E. 3 brg.	IM-15	600
2	100	Gen. Elec.	I-M	1800
1	100	G.E. Vertical	MT553	1200
2	100	Gen. Elec.	IM-15A	514
1	100	Northwestern	HW75A	900
1	100	Gen. Elec.	I-M	720
1	100	Cr. Wheeler	SR	600
1	75	Gen. Elec.	I-M-H13	1200
1	75	Gen. Elec.	I-M-14	720
1	75	Gen. Elec.	MT558	600
1	75	G.E. 2200V.	MT556	720
1	75	Gen. Elec.	MT537	1800
1	75	Whse. 2200V.	CW	600
1	60	Fair. Morse	BY	720
1	60	Whse. 2200V.	CW761C	900
1	50	Allis Ch.	ANY	900
1	50	Howell	SR437	1200
1	50	Gen. Elec. int.	ITC5013	600
1	50	Gen. Elec.	I-M	720
1	50	Gen. Elec.	MT336	1200
2	40	Whse.	CW636A	1200

A. C. MOTORS—SYNCHRONOUS

HP	Mfr	Type	Volts	Speed
600	Gen. Elec. (3)	TS	2300	514
300	Whse.	G	2200/440	600
300	Gen. Elec.	ATI	440	720
250	Gen. Elec. (2)	TS	2300/440	360
229	G.E. 3 brg. .8PF	ATI	220/440	600
200	G.E.	TS	220/440	150
200	G.E. .8PF	ATI	220/440	900
190	El. Machy.	3 brg.	220/440	514
150	Gen. Elec.	ATI	220/440	600
150	Gen. Elec.	ATI	220/440	360
100	American b.b.	YGH	220/440	900
125	El. Machy. (2)	B.B.	2400/4800	900

A. C. MOTORS—SQUIRREL CAGE

3 Phase 60 Cycle 220 or 440 Volts

Qu	HP	Mfr	Type	Speed
2	500	Fair. Morse 2200V.	HS	1200
1	335	Gen. Elec.	KT420	400
1	330	G.E. 2200V.	KTP561	1800
1	300	Allis Ch. 2200V.	AN	720
1	250	Gen. Elec.	FT549AZ	3600
1	250	Gen. Elec.	FT549	3600
1	200	Allis. Ch.	AN	1200
1	200	Whse. b.b. NEW	CS875	1800
1	150	Gen. Elec. TEFC b.b.	KM338	1200
1	150	Reliance b.b. NEW	B6085	1200
1	150	Gen. Elec.	KF557	1200
1	150	Gen. Elec. 2200V	IR-E13A	1800
1	133	Cen. 2200V. b.b.	SC	1800
1	125	F.M. 2200V. vertical	UH-16D	1200
1	100	Gen. Elec.	I-K	720
2	100	Allis Ch. 2200V.	AR226	1200
1	100	Rel. TEFC NEW	C5085	1200
1	100	Gen. Elec. b.b. NEW	K5048	1800
1	75	Fair. Morse b.b.	HJQ	600
1	75	Reliance b.b. NEW	C8084	900
1	75	Reliance b.b. NEW	C505	1800
1	75	Gen. Elec.	KT329Y	3600
2	75	Reliance b.b. NEW	C505	1200
2	75	Gen. Elec.	I-K-14	600
1	75	L. Allis b.b. Spl.	FX505	1200
1	75	G.E. Expl. Pf.	K6325	1200
1	75	F. Morse b.b.	NEW	720
1	60	Gen. Elec.	I-K	600
4	60	G.E. 2200V.	KT533	1800
1	60	G. E. hitorq	KG504	1200
2	60	Reliance b.b. NEW	B504	1800
1	60	Reliance TEFC NEW	C505	1200
2	60	Reliance b.b. NEW	C504	1200
1	60	Whse. H.T.	C8504	1800
1	50	Rel. TEFC New	B1428	1800
2	50	Gen. Elec.	KT346	720
1	50	Gen. Elec.	KT566	450
2	50	G.E. Vertical	KT548	720
2	50	Reliance b.b. New	CC5041U	900
1	50	L.A. 2200 V. Ex. p.f.	K5048	1800
3	50	Gen. Elec.	KT536	1200
2	50	Whse.	C8	1200
1	50	G.E. NEW b.b. HT	KG405	1800
2	50	Reliance b.b. NEW	C445	1200
1	50	Whse. hislip	WL807	900
1	50	Allis Ch. 2200V.	AR445	1800
2	40	Gen. Elec.	KT542	720

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1500 KVA FREQUENCY CHANGERS
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1500 KVA 3/30/460, 360 RPM
Complete Controls
ALL G. E. ATI & ATB
WILL SELL MOTORS OR GENERATORS SEPARATELY

2100 HP SYNCHRONOUS MOTORS
G. E. ATI-C UNITY PF, 3/60/2300
360 RPM TWO BEAR. PED.
RED, VOLTAGE MANUAL CONTROL

1500 KVA AC GENERATORS
G. E. ATB-C 80% PF 3/30/460
360 RPM, SINGLE BEAR.
COMPLETE CONTROL PANELS

S. M. DAVIS
510 LaSalle St. St. Louis 4, Mo.

---

asme — BOILERS — Nat'l B'd.
2—404 H.P. Springfield sectional header
1—250 H.P. Stirling, Class-H. Coxe Stoker
2—400 H.P. built in 1942 (used 3 years) COMPLETE PLANT, forced & induced draft fans, stacks, Spreader stokers & oil burners.
H. P. BREARLEY
34-23 91st STREET JACKSON HEIGHTS, N. Y.

---

500 HP Bros W.T. Boiler, Bros Sprdr. stkr. $7,000
500 HP Vogt W.T. Boiler, Firite Spr. stkr. $7,000
250 HP Vogt W.T. Boiler, Westphse Undf. '' $4,500
218 HP Vogt W.T. Boiler, compl. new tubes $3,500
2—150 HP HRT boilers, shell only, $750 & $1,000
Westphse Underf. stkr. 114' gr., prac. new, $2,000
ALLIED EQUIPMENT COMPANY
Louisville, Ky.—950 Cherokee Rd., HI 2138
Woodside, L.I.—4205 48th Ave., IR 6-8776

675-312-260-125 KVA Eng. Gen. Sets
220 HP 160# 3-drum Low Head Boilers
75 & 8 Ton O.E.T. Cranes—Motors
250 HP Westge. 900 RPM Sq. Cg. Motor
16-22½' Structural Steel Posts
2500 & 2000' Motor Drv. Air Compressors
H. & P., 6719 Etzel, St. Louis 14, Mo.

FOR SALE
Power plant equipment. Steam, Diesel, electrical, boilers, engines, turbines, generators, new or used.
PENN MACHINERY COMPANY
Jackson, Miss.

CONSULT US FOR
Diesel Gasoline and Steam Generators.
Electrical and Industrial Equipment
POWERITE CORPORATION
140 Cedar St. New York 6, N. Y.
Dept. 105 BA 7-8199

1050 HP SLIP RING MOTOR
G.E. MT8 3/25/2300 375 RPM, PED. BEAR. #3884907 with AUTOMATIC Control Panels, Six Point. Reversing.
S. M. DAVIS
510 LaSalle St. St. Louis 4, Mo.

F. D. & I. D. FANS
Turbine Driven
American Blower Corp.
Used only about 6 Mths. for 1000 H.P. Boiler.
MERRILL and COMPANY
407 So. Dearborn St. • Chicago 5, Illinois

5000-KW. G.E. TURBINE-GENERATOR

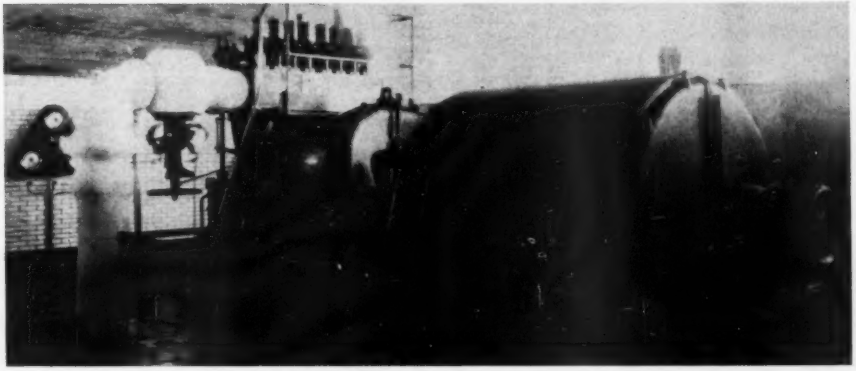
A COMPLETE UNIT.

Will DELIVER IT DUTY FREE TO ANY POINT IN CANADA OR U.S.A.

A $75,000.00 SAVING IN DUTY CHARGE OVER A NEW UNIT
WITH 15-18 mos. WAIT for Delivery of New Machine.

We Give *IMMEDIATE DELIVERY.*

HOW? TURBINE IN STORAGE: IS OUR PROPERTY



$10,000.00 Additional Saving to BUYER to Cover Cost of Miscellaneous Materials required when installing a New Turbine. OURS IS A COMPLETE UNIT. ALL Piping and Incidentals, Valves, Accessories, Etc., are Furnished with our 5000-KW. unit.

CONDITION: EXCELLENT: GOOD FOR 20 YRS. CONTINUOUS SERVICE
Steam Pressure 200-lbs., psig.: 3/60/2300/4160-V.: 7,000 sq. ft.,
2-Pass Surface Condenser with all Auxiliaries: D.C. Exciter.

DIESEL POWER, BOILERS: A COMPLETE LINE OF BOTH IN OUR STOCK.
Also 25 Complete Turbo-Generator Sets in Stock. Capacities 500KW.
to 20,000-KW., Condensing and Non-condensing units.

ALWAYS GET WEAVER'S PRICES BEFORE BUYING — ARE REAL MONEY SAVERS.

CORRESPONDENCE INVITED

TELEPHONE,
WIRE OR
WRITE.

CHARLES WEAVER, M.E.
41st FLOOR PENOBSCOT BLDG.
DETROIT 26, MICHIGAN

TELEPHONES
WOODWARD 1-1340
WOODWARD 1-1341
WOODWARD 1-6038

Send Today for BULLETIN 415: Gives Specs. on Above 5000-KW. Is Free.
It Is Priced Very Low for Quick Sale.

MOTORS - M.G. SETS - CONTROLS

AT REDUCED PRICES!

M-G SETS

KW	D.C. Volts	A.C. Volts	Mfg.
400	125/250	2300	Ideal
200	250	2200	Whse.
200	125/250	2200	G.E.
150	250	440	G.E.
100	250	220/440	Star
100	250	440	G.E.
75	250	440	Allis
60	250	220	G.E.
30	250	440	Ideal
10VS	250	440	Rel.
7½VS	250	220/440	Rel (New)

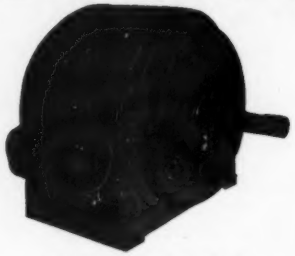
Reconditioned and guaranteed

M-G SETS

2—50 KW Ideal, 250 Volt D.C. 75 HP, 1800 RPM, 440-3-60, 70% Syn. Motor Frame 326.

SYNCHRONOUS

HP	RPM	Volts	Mfg.	Type
900	150	2200	Allis	80%
650	138	2300	Whse.	Engine
600	1200	440	Elliott	80%
400	900	2300	Whse.	80%
400	720	440	G.E.	80%
350	200	2300	Whse.	100%
300	720	440	Whse.	80%
250	514	2300	A-C	90%
200	1200	440	G.E.	100%
150	900	2300	G.E.	100%
75	900	220	E-M	80%



SLIP RING — R & G.

HP	RPM	Volts	Mfg.
800	514	2300	Whse.
700	514	2200	G.E.
500	450	2300	G.E.
450	514	440	Whse.
400	900	2300	G.E. (New)
350	450	2300	Whse.
300	600	440	G.E.
200	450	2300	Burke
150	1200	2300	G.E.
50	720	220	Whse.

NEW SLIP RING

2—New 500 HP, 1200 RPM Elliott, 220/440 V., 3 Ph., 60 Cy., Shaft 4½" dia. x 8" long. (Photo above.) Control Available.

NEW DIRECT CURRENT

230 Volt Drip proof — beall bearing

Qu.	HP	RPM	Mfg.	Frame
1	3	690/2660	G.E.	284
10	5	850/1700	G.E.	CD-66
5	7½	575/1750	G.E.	CD-77
1	10	575/2300	L.A.	4051
3	10	1750	Rel.	T-34

Reconditioned and guaranteed

230 VOLTS D.C.

HP	RPM	Mfg.	Brg.
250	400/1200	E-D	Ball.
150	350/1200	Whse.	Ped.
150	250/1000	Rel	Sleeve
100	475/1350	E-D	Ped.
75	500/1500	C-W	Sleeve
75	300/1200	Whse	Sleeve
50	400/1200	G.E.	Sleeve
50	350/1050	Whse.	Ball.
40	400/1600	C-W	Ball.
30	400/1200	Rel (TEFC)	Ball.
30	500/1500	Rel	Ball.
30	700/1400	Rel (TEFC)	Ball.
30	250/1000	Whse.	Sealed Sl.
25	690	Rel	Ball.
25	1150/2300	G.E. (TEFC)	Ball.
20	300/1200	Rel	Ball.
15	575/1000	Rel	Ball.
15	575/1725	L.A.	Ball.
15	700/1350	Rel	Ball.
10	400/1600	Whse.	Sleeve
10	600/1200	Rel (TEFC)	Ball.
10	850	Rel	Ball.
7½	400/1600	Rel	Ball.
7½	600/1800	Rel (TEFC)	Ball.

Buy from BOSWICK with confidence

WAlbridge 1195

BOSWICK ELECTRIC CO.

P.O. BOX 55 AKRON 9, OHIO

MOTORS - M. G. SETS - COMPRESSORS, ETC.

FAST SHIPMENT

MOTOR GENERATOR SETS

3 ph. 60 cy.

KW	MAKE	RPM	D.C. VOLTS	A.C. VOLTS
500	Cr. Wh.	720	250	2300
400	West.	720	550	2300
300	Ridg.	1200	250	2300
300	G.E.	1200	250	4000/2300
300	West.	1200	550	4000/2300
240	G.E.	1200	250	4000/2300
200	G.E.	1200	250	4000/2300
150	Ridg.	900	250	2300
100	Ridg.	1200	250	2300/440
75	West.	900	75	440/220
35	G.E.	1800	125	440/220

Also Smaller Units In Stock

ROTARY CONVERTERS

KW	MAKE	RPM	D.C. VOLTS	A.C. VOLTS
500	GEHCC6	1200	250	4000/2300
300	G.E. HC12	600	250	4000/2300
300	G.E. HCC6	1200	250	4000/2300
150	West.	1200	250	4000/2300

Other sizes available

AIR COMPRESSORS

741 CFM, 100#, OCB, Chg. Pn. belted 150 HP motor

500 CFM, 100#, Allis Rotary direct connected 100 H.P. B.B. Motors.

A.C. MOTORS—3 Ph. 60 Cy.

HP	MAKE	RPM	TYPE
1500	West.	435	CW—Sl.Rg.
500	G.E.	450	MT412—Sl.Rg.
350	West.	600	CW1106—Sl.Rg.
300	G.E.	450	IM—Sl.Rg.
200	G.E.	1200	MI—Sl.Rg.
160	G.E.	600	IK-16—Sq. Cg.
150	West.	514	C5954—Sq. Cg.
150	G.E.	600	ATI—Syn.
125 (3)	Allis	900	ARY—Sq. Cg.
100 (2)	Allis	720	ARX—Sq. Cg.
100 (5)	West.	1200	C5752C—Sq. Cg.
100 (2)	G.E.	450	IM16—Sl.Rg.
75	West.	900	MS342 Sq. Cg.
75	G.E.	600	ITC5013A
50/12.5	G.E.	900/450	IM 2200 v.
40	G.E.	1200	MT336—Sl.Rg.

Also Smaller Units In Stock

D.C. ADJUSTABLE SPEED MOTORS

230 Volts

HP	MAKE	SPEED	TYPE
150	West.	400/800	SK201
125	West.	450/1000	SK193
60	West.	435/870	SK185
50 (2)	Elec. Dyn.	190/760	

Also Smaller Units In Stock

Send us your inquiries for any POWER EQUIPMENT you may require.

MOORHEAD ELECTRICAL MACHINERY COMPANY

361 Noblestown Road Oakdale, Penna. Pittsburgh District

TRANSFORMERS — FOR SALE

1 Phase 60 Cycle

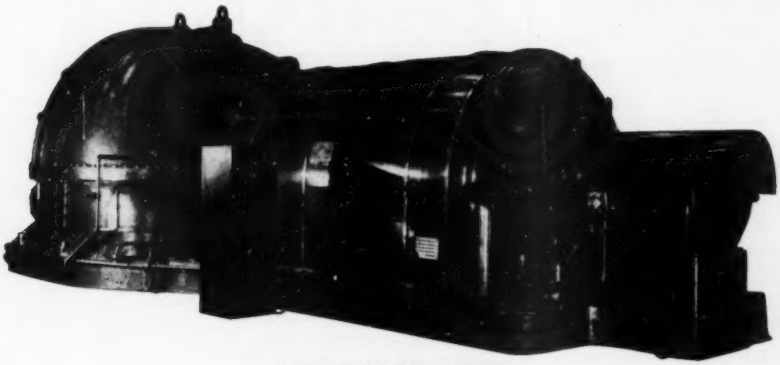
Rebuilt and Guaranteed

3—1250 KVA—G.E. 13800 2400
3—1000 KVA—G.E. 13800 480
3—1250 KVA—G.E. 6900 480
3—1000 KVA—G.E. 4800 480
6— 500 KVA—West. 2400 240/480
9— 333 KVA—West. 6900 480
9— 333 KVA—West. 4800 480
9— 333 KVA—West. 2400 480
3— 200 KVA—G.E. 2400 480/240
3— 150 KVA—G.E. 2400 480/240
3— 100 KVA—G.E. 2400 480/240
3— 100 KVA — G.E. 6900/11950Y 460/230
3— 75 KVA—West. 4800/2400 460/230
3— 50 KVA—G.E. 4800/2400 460/230/115
3— 37½ KVA — G.E. 4800/2400 460/230/115

We Also Solicit Your Inquiries for Special Transformers Including Furnace Transformers

BUFFALO TRANSFORMER CO.
1510 NIAGARA ST.
BUFFALO 13, N. Y.

25,000 KVA—20,000 KW, 80% P.F., 3 phase 60 cycle, 13,200 volts, 1800 RPM General Electric Company condensing turbine generator unit 215 P.S.I.G. 540-550° total temperature complete with direct connected shaft exciter, switchboard and instruments, a 30,000 square foot 2-pass Westinghouse surface condenser, motor driven and turbine driven pumps and condensing accessories.



ACTUAL PHOTOGRAPHIC VIEW

EXCELLENT CONDITION — COMPLETE INSTALLATION — PROMPT DELIVERY

TURBINE-GENERATOR UNITS

3 phase, 60 cycle

6250 KVA G.E. condens., 3-stage, 2300/4000 volts, 200# P.S.I., 600°TT.

3125 KVA G.E. condens., 150#, 550 volts.

2500 KVA G.E. Type ATB, Form HT, 2300/480 volts, 3600 RPM, two bearing alternating current generator LESS TURBINE.

2500 KVA G.E. condensing 200 P.S.I. 2400/600/480 volts.

937 KVA G.E. bleeder condensing 215 P.S.I.G., 15# extraction, 2300 volts.

780 KVA Allis condensing, 150 PSI, 480 volts.

625 KVA G.E. non-condensing 150 P.S.I., 20# back, 480 volt.

625 KVA G.E.—Murray condensing 250 P.S.I., 2300 volts.

125 KVA G.E. non-condensing, 150-200 P.S.I., 2300 volts.

125 KVA Westghse. non-condensing 150/250 P.S.I. 2400 volts NEW

Direct Current

300 KW Westghse. 3-wire, 250 volt 150/250# P.S.I. non-condensing

150 KW (2) Westinghouse-Worthington, 250 volts, 3-wire, 225-250 P.S.I. condensing.

100 KW (2) G.E. 125 volt, 200/275 P.S.I. non-condensing

75 KW (2) Westinghouse-Moore, 120 volt, 200# P.S.I. condensing.

60 KW (3) new Westinghouse, 120 volt, 200# P.S.I. condensing.

MOTOR GENERATOR SETS

150 KW G.E., 125 volt direct current generator connected 225 HP, 3 phase, 60 cycle, 220 volt, synch. motor.

100 KVA Westghse. 60 cycle, 2400 volts, 900 RPM alternator direct connected 135 HP, 220 volt direct current motor.

62½ KVA G.E., 60 cycle, 2300 volt alternator to 75 HP, 125 volt DC motor.

MARCH BARGAINS
SPECIALLY PRICED

22,500 sq. ft. Alberger — 21,000 sq. ft. Wheeler, 4,400 sq. ft. Worthington SURFACE CONDENSERS

3—10,000 GPM 24" suction 20" dis. Cent. pumps each direct connected motor.

1—10,000 GPM 24" suction cent. pump direct connected motor.

1—10,000 GPM 24" suction cent. pump direct connected G.E. non-condens. turbine.

1—5425 GPM, 70 foot head Centrifugal pump connected 125 HP 60 cycle, 2200 volt, 1750 RPM G.E. motor.

2—1000 GPM, 1270 foot head, 4-stage Morris pumps each connected 417 HP, 390# P.S.I. non-cond. G.E. turbine.

1—G.E. Bank of Scott connected 2 to 3 phase, 60 cycle transformers, 2500 KVA capacity.

1—20 KW 125 volt direct current generator connected Hill Diesel engine.

9—250 KVA single phase, 60 cycle Westinghouse transformers 11,000/444 volts.

UNAFLOW GENERATOR UNITS

Alternating Current—3 phase, 60 cycle

625 KVA 40°C Rise, General Electric, 240 volts generator connected Skinner non-condensing engine. 150 P.S.I.

500 KVA G.E., 2400/480/240 volts generator connected Ames Vertical Engine, 150#.

375 KVA G.E., 2300/440 volts generator connected 23"x24" Skinner Horizontal Engine.

175 KVA Westghse., 240 volt generator connected Skinner Horizontal Engine, 125-150# P.S.I., 5# gauge back.

Direct Current

400 KW G.E. 250 volts, 360 RPM generator connected Skinner vertical engine 150#.

275 KW Westinghouse, 250 volt generator connected Ames vertical engines, 150#.

250 KW (2) G.E., 3-wire, 250 volts generators connected Skinner engines, 150#.

SYNCHRONOUS MOTORS

5000 KVA Westinghouse, 4000 volt, 720 RPM Electrical Synchronous (condenser).

900 HP Allis, 2200 volts, 150 RPM.

300 HP G.E., 80% P.F., 2300 volts, 720 RPM.

DIESEL GENERATING PLANTS

4—1200 HP, 8 cylinders Model 38D8½ opposed piston, 720 RPM, Fairbanks-Morse Diesel engines each direct connected to a 900 KW, 250 to 375 volts, 720 RPM compensated shunt wound enclosed Elliott direct current generators.

3—187 KVA, 3 phase 60 cycle, 240 volts, 400 RPM generators direct connected to 225 HP, 6 cylinders Buckeye Diesel Engines.

UMC UTILITIES MACHINERY CORP.
1965 EAST 6th STREET • CLEVELAND 14, OHIO • Long Distance 422

BREW-WOLTMAN OFFERS

TURBINE UNITS

1—12500 KVA Allis Cond. 60 cy. 13800 V. 300-lb.
1—10000 KVA G. E. Cond. 25 cy. 6600 V. 200-lb.
1— 5000 KVA West. Extr. Cond. 60 cy. 480 V. 385-lb.
1— 3125 KVA G.E. Cond. 60 cy. 2300 V. 150-lb.
1— 2500 KVA Worthington Non-C. 60 cy. 2300 V. 150-200-lb. 40-lb. BP
1— 2500 KVA G. E. Extr. Cond. 60 cy. 480 V. 185-200-lb. steel valve chest.
1— 2500 KVA G. E. Cond. 60 cy. 2300 V. 150-lb.
2— 2250 KVA G. E. Cond. 60 cy. 240-400 lb.
1— 1875 KVA Moore Cond. 60 cy. 2300 V. 225-lb.
1— 1250 KVA Allis Cond. 60 cy. 2300 V. 150-200 lb.
1— 1250 KVA Allis Cond. 60 cy. 2300 V. 150-200-lb.
2— 1250 KVA Elliott Cond. 60 cy. 480 V. 150-200-lb. 680" Surface Condenser
1— 938 KVA G.E. Extr. Cond. 60 cy. 240 V. 200-lb.
1— 750 KVA G.E. Extr. Cond. 60 cy. 480 V. 200-lb.
2— 250 KVA Elliott Non-C. 60 cy. 208 V. 200-lb. 5-lb. BP
1— 75 KW West. Cond. 125/250 V. DC 400-lb.

DIESEL ENGINE UNITS

2—1400 HP Fair. Morse 2400 V. 60 cy.
1— 900 HP Amer. Loco. 250 V. DC
3— 700 HP Gen. Motors 2300 V. 60 cy.
3— 650 HP Amer. Loco. 440 V. 60 cy.
2— 600 HP Amer. Loco. 250 V. DC
1— 600 HP Fair. Morse 2400 V. 60 cy.

STEAM ENGINE UNITS

1—500 KVA Skinner Uniflow 440 V.
1—250 KVA Ames Vertical Uniflow 480 V.
1—250 KVA Ames Uniflow 480 V.
2—187 KVA Ames Vertical Uniflow 240/480 V.
1—156 KVA Ames Vertical Uniflow 240 V.

ROTARIES—60 CY.

QU.	KW.	MFR.	VOLTS-DC	TRANS.	RPM
1	3250	G.E.	225/285	13800	300
1	2000	A.C.	600	4130	514
2	1000	West.	600	4150	720
1	1000	G.E.	600	13200	900 Auto.
2	500	West.	250	13200	1200

SPECIALS

TURBINE UNITS

2—1250 KVA, Elliott 3/60/480 V. 3600 RPM 150-200 lbs. IP 600° TT with dir. conn. exciter, surface condenser & pumps.

1—1250 KVA, Allis Chalmers 3/60/2300 V. 3600 RPM, 200-lb. IP 500° TT with 25 KW motor or dual drive exciter and condenser.

MERCURY ARC RECTIFIERS

QU.	KW.	KIND	DC VOLTS	TRANS.
3	4500	Multi Anode	600	13800
2	1850	Ignitron	300	13000
1	1000	Ignitron	600	13800

MOTOR GENERATOR SETS—60 CY.

QU.	KW.	MFR.	VOLTS-D.C.	A.C.	RPM
1	1500	West.	250	4600	514
1	1000	G. E.	600	13200	514
1	300	West.	125	2300	720
1	400	G. E.	250	6600	720
1	300	G. E.	250	2300	1200
1	75	Other	240	440	1200
1	75	West.	125	440	1200

SYNCHRONOUS CONDENSERS

QU.	KVA	MFR.	VOLTAGE	RPM
1	2500	G.E.	2400/4160	720
1	2000	West.	2300	720
1	1500	G.E.	4600	900
1	1500	West.	2300	900
1	1000	West.	2300	900

SYNCHRONOUS MOTORS—60 CY.

QU.	HP	MFR.	VOLTAGE	RPM
1	4350	Cr. Wh.	13800	514
1	1000	E. M.	2400	720
2	700	West.	2300	200
1	500	G.E.	440	360
2	350	G.E.	2300	257
1	300	G.E.	2300	600
1	300	West.	2300	900

FREQUENCY CHANGERS

QU.	KVA	MFR.	CYCLES	RPM
1	3125	G. E.	25/60	300
1	3000	G. E.	60/25	300
2	2500	G.E.	25/62½	750
1	2450	G. E.	62½/25	750
1	1250	G. E.	25/60	300
1	1250	West.	25/60	300
2	1000	G. E.	25/60	300
1	500	Al. Ch.	25/60	300

TRANSFORMERS—60 CY.

1— 7500 KVA G.E. 138000—41000, 3 ph.
3— 3333 KVA West. 132000—7620/13200 Y
1— 2000 KVA G.E. 69000—13800/23900 3 ph.
3 —1000 KVA West. 66000—7200
1— 2500 KVA G.E. 59/73 KV, 5 taps, 3 ph.
3— 100 KVA West. 44000—7200/12470 Y
3— 75 KVA G.E. 44000—2300/4600
3— 8333 KVA West. 43800—13800
4— 6667 KVA G.E. 38100/66000Y—12700/22000 Y/13200
1—18750 KVA A.B.B. 34840—11000, 3 ph.
2— 7500 KVA Al. Ch. 33000—13800, 3 ph.
1— 5000 KVA G.E. 33000—2300/4600, 3 ph.
6— 200 KVA G.E. 33000—2300/6900
6— 167 KVA G.E. 33000—2300/4000Y
6— 75 KVA Mol. 33000/16500—2300/6900
3— 75 KVA Wag. 33000—7200/12470 Y
6— 50 KVA G.E. 33000—2300
2—4500 KVA G.E. 27000—2300, 3 ph.
3— 3750 KVA West. 26400/13200—2400
4— 450 KVA Al. Ch. 25410/44000—13280/23000
2— 1000 KVA G.E. 22000/11000—2300, 3 ph.
3— 750 KVA West. 13200—440
2— 200 KVA G.E. 11500—220/110
3— 200 KVA Mol. 11000—2300
1— 1500 KVA West. 4000—2300, 3 ph. Auto
3— 250 KVA Al. Ch. 2300—460
6— 75 KVA G. E. 480—120,240

OIL CIRCUIT BREAKERS

4— 400	A. 154 KV G.E. FHKO-39-2500		Outdoor
1— 600	A. 132 KV G.E. FHKO-60-1500		Outdoor
2— 600	A. 73 KV G.E. FHKO-139-1000		Outdoor
1— 400	A. 73 KV G.E. FHKO-236-500		Outdoor
1— 600	A. 37 KV G.E. FHKO-139-450		Outdoor
2— 400	A. 37 KV G.E. FHKO-236-500		Outdoor
4— 600	A. 15 KV G.E. FHKO-139-750		Outdoor
2— 600	A. 15 KV West. B-28-B-500		Indoor

PARTIAL LIST—WE HAVE ALL CLASSES OF POWER EQUIPMENT

BREW-WOLTMAN & CO., INC.

50 Church Street — New York City 7, — WOrth 4-1470

NORTHERN METAL CO. — MACHINERY at REDUCED PRICES

BOILER

Water Tube. Babcock & Wilcox, 1945. 2 Drum. Bent Tube. Economisers. Internal Desuperheater. Superheaters: W.P. 400 P.S.I. Hydrostatic Press. 718 P.S.I. Heating Surfaces: 2441 sq. ft. Superheater 350 sq. ft. Economiser 1620 sq. ft. 3 Todd "Hex Press" Fuel Oil Burners. Diamond Soot Blowers. Auxiliaries available.

BOILER

Mfr. Vancouver Iron Works, Vancouver, B. C. Type: Yarrow, 3 Drum. Bent Tube, Water Tube, Oil fired, 4 Burners, 55,000 lbs. steam per hr. Max. Heating Surface 6256 sq. ft. Working Press. 225 P.S.I. Test Press. 387 P.S.I. Built 2/7/43.

NUMEROUS OTHER ITEMS ARE AVAILABLE

MILNOR & BLEIGH STS. • PHILA. 35, PA.

Phone MAyfair 4-1400

AC STEAM ENGINE GENERATOR SET consisting of:

1—Ames steam engine (condensing) (22x24") 200 RPM—Engine No. 41708

1—315 KVA Westinghouse A.C. Generator—No. 2193167—Three Phase, 60 Cycle—2400 Volt

On foundation, Minnesota shipping point
$4,000.00

GENERAL ELECTRIC AC GENERATOR

180 KW—900 RPM, 2400/4160 Volt—54/31.2 Amps, Three Phase, 60 Cycle—Type ATB, Frame 7635—225 KVA, rated at .8 Power Factor, Model MIN 840, with Direct Connected Exciter—4.5 KW, 900 RPM—Type EF, 36 amps., Form EB, Frame 75

Completely rebuilt by G.E. shop
F.O.B. our warehouse and guaranteed
$1,500.00

PORTER ELECTRIC CO., INC.
116 THIRD AVE. N.
MINNEAPOLIS 1, MINN.

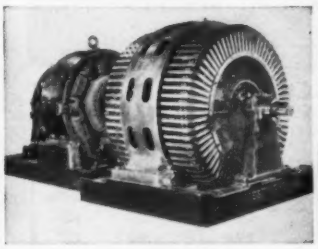
IT ISN'T RE-NU-BILT UNLESS

It Comes from

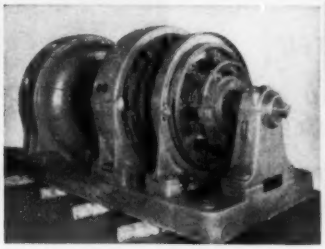
BELYEA

"SUCCESSFUL OPERATION GUARANTEED"

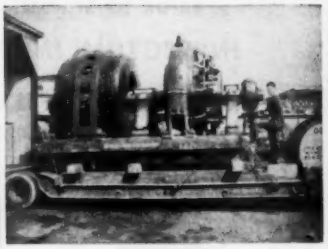
Three Recent Stock Arrivals



500 KW-MG



750 KW-MG



2000 KW-MG

MOTOR GENERATOR SETS

3 ph. 60 cycle

Qu.	KW	Make	Speed	D.C. Volts	A.C. Volts
2	2000*	G.E.	500		6600/11000
1	1800	G.E.	600	125/250	4000
1	1500	Whse.	600	600	2300/4600
1	1500	G.E.	360	275	2200/4400
1	1000	Whse.	900	600	2300/4150
1	1000	G.E.	900	600	2300/4150
1	800	Whse(3U)	1200	600	2300
1	750	Whse.,	900	250	2300
1	500	G.E.	720	125	2300/4000
1	500	Whse.	900	250	440
1	400	G.E.	720	250	440/2300
1	400	G.E.	1200	125/240	440
1	400	Whse.	1200	250	2300
1	350	G.E.	900	125	2300/4150
1	150	G.E.	1200	250	2300
1	150	Whse.	1200	275	2300
1	150	Cr. Wh.	1200	250	440
1	140(3U)	Cr. Wh.	690	125/250	2300
1	100	G.E.	1170	125	220
1	100	Delco	1200	125/250	440
1	75	G.E.	1200	125	4000
1	75	G.E.	1200	250	440
6	70	G.E.	1200	70	220/440
1	60	G.E.	1200	250	2300
1	50	Whse.	1200	120	220

* 25 Cycle

ROTARY CONVERTERS

60 Cycles

Qu.	KW	Make	Speed	D.C. Volts	A.C. Volts
1	2000	G.E.	514	600	13800
1	1000	Whse.	900	600	11000
1	750	Whse.	900	600	13200

TURBO GENERATORS

Qu.	KW	Make	Desc.
1	2500	G.E.	Condensing—150# ISP 2300 V 3 ph. 60 cy. with surface condenser. Recently Rebuilt.
1	1000	G.E.	Condensing 135/150# ISP 2300/4150 V 3 ph. 60 cy.
2	750	G.E.	Condensing 425#-725°TT ISP-440V-3 ph. 60 cy. New—1944
1	625	Whse.	Non-condensing, 125/150# ISP, 5/20# B.P., 480 v., 3 ph., 60 cy., with exciter
1	400	Whse.	Non-condensing 125/150# ISP 5/10#BTU 46/480v. 3 ph. 60 cy.
2	400	G.E.	Condensing. 275# ISP Geared to 1200 RPM. 120/240V. D.C. Generator.
1	300	G.E.	Non-condensing 150/175# ISP 5/15# B.P. 480V. 3 ph. 60 cy.
1	300	Al. Ch.	Condensing 425# ISP Geared to 1200 RPM 120/240V. D. C.
2	200	Cr. Wh.	Condensing 250# ISP GEARED to 1200 RPM—125V. D.C. Gen.
1	200	Whse.	Non-condensing 150# ISP 7# B.P. 240V. 3 ph. 60 cy.

D. C. MOTORS

HP	Make	Type	Volts	Speed
1—1750	Whse.		600	525/720
1—1500	Whse.		525	600
1— 940	Whse.	QM-R.Brg.	250	140/170
1— 800/1000	Whse.		450	600/720
1— 650	G.E.	MPC	250	115/145
1— 600	Al. Ch.	MILL	230	400/800
1— 300/400	G.E.	DYNA	250	1325/2500
1— 350	Cr. Wh.	CCM-151H	230	1100
1— 225	Whse.	MQ	250	300/900
1— 200/300	G.E.	MPC	230	360/720
1— 275	Whse.	QM-600-6	230	425/850
1— 250	G.E.	MPC	230	400/500
1— 150	G.E.		600	250/750
10— 150	Cr. Wh.	83H	230	800
1— 150	Cr. Wh.	CMC-65H	230	1150
1— 150	Cr. Wh.	CCM-152H	230	300/1050
1— 50/120	G.E.	MCF	230	250/1000

FREQUENCY CHANGERS

1—1000	A.C.	25/62½		2300/2300
1—1000	G.E.	25/58	Cycle	4400/2300
1— 500	A.C.	25/60	Cycle	11000/2300V

SYNCHRONOUS CONDENSERS

Qu.	Kva.	Make	Type	Volts	Speed
1	5110	Whse.		4150	600
1	4000	G.E.	TSC	2400/4800	900
1	3000	Whse.		4800	720

TRANSFORMERS

60 Cycles

Qu.	KVA.	Make	Type	Ph.	Voltages
3	2666	Whse.	OISC	1	6600/11000
1	1500	G.E.	HT	3	13800x460
3	1250	G.E.	H	1	6600x500
1	1650	G.E.	WCTH	3	11000x445
1	600	Al.Ch.	OISC	3	4000/2300x216
1	500	Whse.	OISC	1	24650x482
1	500	Whse.	OISC	3	13800x230/460
3	333	Pitts.	OISC	1	26400x2600
6	250	G.E.	HT	3	13200x240/480
3	250	G.E.	HT	3	6900x240/480
9	250	G.E.	HT	3	2400x240/480
3	150	Maloney	OISC	1	13800x2300/4600
1	100	G.E.	H	1	450x220

RECTIFIERS

1— 750	G.E.	BHW	575	2300
1—1000	A.C.	B-612	625	13500
1—1000*	A.B.B.	GRS	625	6600/13200

*This unit with full automatic control good for both 25 and 60 cycle.

A. C. MOTORS

3 ph. 60 cycle

SYNCHRONOUS

HP	Make	Type	Volts	Speed
2—3500	G.E.	TS	2300	257
1—2100	G.E.	ATI	4600	514
2—2000	Whse.		2300	120
1—1470	Whse.		4600	900
2— 900	Al. Ch.	(New)	2300	150
1— 650	Whse.	G	2200	138
1— 600	Whse.	Syn.	440	360
1— 450	Whse.	Eng.	2200	138.5
2— 250	G.E.	TS	2200	150
1— 300	G.E.	ATI	440	720
1— 300	Whse.		2300	720
1— 225	G.E.	ATI 1-Brg.	440	900
1— 125	G.E.	ATI	440	450
1— 100	Whse.		550	600

SLIP RING

1—1000	Whse.	CW	2300	444
1— 700	Whse.	CW	2300	900
1— 500	G.E.	IP	550	505
1— 500	G.E.	IM-Mill	2200	450
1— 350	G.E.	MT-442-Y	2200/4000	253
1— 300	Al. Ch.	3 Brg.	2300	505
1— 300	G.E.	IM	440	720
5— 300	Al. Chal.	ANY	2300	708
1— 250	Al. Chal.	ANY	440	585
1— 250	G.E.	M-567-TEFC	440	600
1— 250	G.E.	MT-424Y	4000	257
1— 250	G.E.	MT-559S	2200	1750
1— 250	Al. Chal	ANY	550	600
1— 200	Al. Ch.	ANY	440	440
2— 150	G.E.	IM-15	440	695
2— 150	Al. Chal.	ANY	440	580
4— 125	G.E.	MT-566Y	440/2200	435
4— 100	G.E.	MT-566Y	440/2200	435
2— 100	G.E.	IM-16	2200	435
3— 100	G.E.	IM	440	600
3— 100	Al. Ch.	ANY	440	695

SQUIRREL CAGE

2— 650	G.E.	FT5503Y	440	3570
2— 450	Whse.	CS	2300/4150	354
1— 200	G.E.	IK-17	440	580
1— 200	G.E.	IK	550	985
1— 200	G.E.	T-557	440	1800
1 —200/112	G.E.	KF-559BS	440	1170/885
2— 150	Wstghse.	CS856S	440	880
1— 200	G.E.	IK	440	600
1— 125	Whse.	MS	440	485
1— 125	(New) G.E	KF-TEFC	440	1190
1— 125	G.E.	KF-TEFC	440	3585
3— 125	Al. Ch.	ARW	2200	1750
1— 125	G.E.	IK	220	900
1— 100	Al. Ch.	AR	2200	1170
1— 100	G.E.	IK-Vert.	2300	450
2— 100	G.E.	ST-513	220/440	1750

RE NU BILT BELYEA MOTORS

BELYEA COMPANY, Inc.

43 HOWELL ST., JERSEY CITY, N. J.

PHONE - JOURNAL SQUARE 2-3334

N. Y. LINE - RECTOR 2-7150

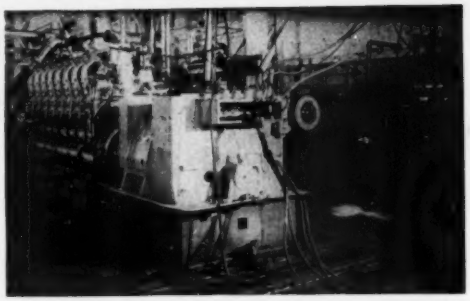
DIESEL POWER

AT 40% TO 60% SAVINGS

EACH ENGINE "REMANUFACTURED"
AND "FULL-LOAD TESTED"
PRIOR TO SHIPMENT

INSPECTION INVITED

ALL EQUIPMENT OFFERED WITH ONE YEAR GUARANTEE



VIEW OF ENGINE TEST STAND FACILITIES AT OUR PLANT IN SAUSALITO (S.F.) CALIF. ALL ENGINE TESTING CONFORMS TO DIESEL MANUFACTURERS' STANDARD METHODS.

A PARTIAL LIST OF OUR INVENTORY

KVA	MAKE	MODEL	HP	RPM	KVA	MAKE	MODEL	HP	RPM
1875	Fairbanks Morse	33E16	2000	300	312.5	Clark	MD-4	375	327
1420	Fairbanks Morse	38D	1600	720	300	Fairbanks Morse	YVA	360	257
1250	General Motors	16-278A	1600	720	250	General Motors	8-268A	350	1200
1000	General Motors	12-278A	1200	720	237	Ingersoll-Rand	S	255	600
937.5	General Motors	12-567	1080	720	200	Buckeye	80	240	600
625	Alco	6-12½x13T	750	600	156	Buckeye	E	190	400
425	Baldwin	VO	510	450	125	General Motors	3-268A	150	1200
400	Buckeye	80	480	600	121	Fairbanks Morse	32E14	140	300
375	Enterprise	DSG-6	450	450	75	General Motors	6-71	90	1200
330	Superior	KNA	396	514	62.5	Int'l Harvester	UD-18	76	1200
312.5	General Motors	8-268A	450	1200	50	General Motors	4-71	60	1200

A. G. SCHOONMAKER COMPANY, INC.

52 CHURCH STREET, NEW YORK 7, N. Y.

SHOPS AND WAREHOUSE: JERSEY CITY, N. J. AND SAUSALITO (S.F.) CALIFORNIA

DIESEL GENERATOR PLANTS

COMPLETE WITH SWITCHBOARDS
1000 KW to 100 KW
STATIONARY and PORTABLE
AT GREATLY REDUCED PRICES
NEW UNIT GUARANTEE

HERCULES ELECTRIC MACHINERY and EQUIPMENT CO.

1442 E. Washington Blvd. Los Angeles 21, Calif.
Phone: Richmond 5269

CENTRIFUGAL PUMPS

4—Allis Chalmers Electrifugal, Size 6" x 5" SSL 20 H.P., 220 or 440 volt, 3/60—1800 RPM, Splash proof. Cap. 1000 GPM, 68' head.
2—Fairbanks-Morse, Size 3"—5532 with 15 H.P. 220/440/3/60—1800 RPM, Splash proof motors. Cap. 300 GPM, 100' head.
2—Vacuum, Size O Nash Hytor, 50 CFM, 15" hg.
2—Beach-Russ, Size 5, Vacuum, 60 CFM, 26" hg.

MOTORS

1—50 H.P. G.E. Slip Ring 220/3/60—900 RPM with drum and grids.

Large stock of pumps, motors and air compressors at all times. Let us have your inquiries.

C-B EQUIPMENT AND PUMP CO.
1440 N. Broadway, St. Louis 6, Mo.
CH 1101 CH 7165

SPECIAL TRANSFORMERS — YOUR SPECIFICATIONS

NEW TRANSFORMERS
OIL COOLED
AIR COOLED
PHASE CHANGES

ARROW TRANSFORMER CO., INC.
1932 E. Westmoreland St., Philadelphia 34, Pa.
GArfield 5-0433

USED TRANSFORMERS
REWOUND
REBUILT
RECONDITIONED

ELECTRICAL CABLE

- for every industrial and power application
- Special constructions. Odd lengths.
- Large stocks on hand of high voltage, lead covered cables not ordinarily stocked by your regular suppliers.
- Cut to length. Reasonably priced.

UNIVERSAL WIRE AND CABLE CO.
2668 N. Clybourn Ave., Chicago 14, Ill.

WORLD'S LARGEST INVENTORY

Established 1934 — D & B Rated

ELECTRIC EQUIPMENT CO., ROCHESTER, N.Y.—MARCH BULLETIN

MOTOR GENERATOR SETS AC — DC

Quan.	KW	Make	Volts
1	1000	General Electric	250
6	1000	General Electric	600
2	500	Westinghouse	250
2	500	Westinghouse	1500
1	500	Westinghouse	125
1	400	Westinghouse	125/250
2	300	General Electric	125/250
1	300	General Electric	500
1	250	General Electric	250
1	200	Westinghouse	250
1	200	General Electric	250
2	200	General Electric	125
1	150	General Electric	250
1	150	General Electric	125
3	100	General Electric	125
4	100	General Electric	250
1	100	Allis-Chalmers	125/250

Plus 238 sets from 1 KW to 75 KW in stock.

DC TO AC

Input		Output
1 300	HP—230 V	200 KW, 440/60/3
1 125	HP—230 V	75 KW, 125 V, DC
1 25	HP—230 V	15 KW, 230/60/1
1 25	HP—230 V	15 KVA, 230/60/1
35 20	HP—230 V	12½ KVA, 440 V, 3 ph, .5 P. F.
40 7½	HP—230 V	7½ KVA, 120/60/1
20 6	HP—115 V	5 KW, 120/60/1
6 3	HP—115 V	2 KVA, 110/25/1
10 1½	HP—115 V	1 KVA, 110/60/1
10 1	HP—115 V	½ KVA, 110/60/1

ROTARY CONVERTORS

Quan.	KW	Make	Speed	Volts
5	500	General Electric	1200	250
7	400	Westinghouse	1200	250
1	100	General Electric	1200	250

P.S.—We Stock Explosion-Proof Motors—Class 1-D & 2-G

AC GENERATORS—ALTERNATORS—CONDENSERS

Quan.	KVA-HP	RPM	CYCLE
1	2500	720	60
1	2500	900	60
1	1675	600	40
2	1500	900	60
1	1430	514	60
1	1250	1200	60
1	1000	750	25
1	800	900	60
3	750	900	60
2	650	139	60
1	500	720	60
1	500	750	25
1	400	450	60
3	400	1800	60
1	350	750	25
1	350	720	60
1	350	225	60
1	333	1800	960
1	320	1200	120
1	300	750	25
1	300	180	60
1	250	720	60

Plus 78 smaller units from 3 KVA to 200 KVA

60 CYCLE MOTORS

SQUIRREL CAGE MOTORS

HP	SPEED	MAKE
500	720	G. E.
400	1200	West.
400	514	West.
300	600	West.
250	3600	G. E.
250	1200	G. E.
200	600	Al. Ch.
200	1800	Wagner
150	720	G. E.
150	600	G. E.
150	1200	Al. Ch.
150	1800	Al. Ch.

P.S. We stock 3500 new and rebuilt 1 HP to 100 HP

SLIP RING MOTORS

Quan.	HP	Speed	Make
1	600	1800	G. E.
1	500	1800	G. E.
1	500	514	Al. Ch.
4	500	900	G. E.
1	350	720	G. E.
1	300	450	G. E.
1	300	514	G. E.
1	300	900	G. E.
1	300	720	G. E.
1	200	600	G. E.
1	200	1200	G. E.
2	150	720	G. E.
1	125	1200	Al. Ch.
1	100	900	Wagner
4	100	450	G. E.
3	75	720	West.

Plus 837 smaller units 1 HP to 40 HP

Mr. "Reddy" Cash
Wants Your Surplus List!

TRANSFORMERS

Quan.	KVA	Primary Volts	Secondary Volts	Phase
2	3000	23,000	2300	3
1	1500	2,300	600	3
1	1000	2,300	220	3
6	1000	66,000	7200	1
3	750	2,400	480	1
6	500	2,400	480	1
3	500	12,000	2300	1
3	450	23,000	440	1
3	333	2,400	600	1
3	333	2,400	240/480	1
3	333	13,200	240/480	1
3	333	11,500	240/480	1
3	300	2,400	120/240	1
6	250	2,400	240/480	1

Plus 734 smaller units 1 KVA to 100 KVA

DC MOTORS

ADJUSTABLE SPEED—230 VOLT

Quan.	HP	Make	Volts
1	300	General Electric	400/800
1	250	West.	250/675
4	40/250	West.	540/3000
1	150	West.	300/900
1	100	Reliance	500/1500
1	100	G. E.	400/1000
1	100	West.	450/1350
1	100	G. E.	1050/4000
1	90	F. M.	500/1500
1	75	G. E.	400/1200
1	60	G. E.	220/1000
1	60	G. E.	300/1200
1	50	G. E.	250/1000
1	50	G. E.	400/1200
1	40	G. E.	250/1000
1	40	Cr. Wh.	400/1600
1	35	West.	250/1000
1	35	G. E.	500/1000
1	30	Reliance	400/1200
1	30	Cr. Wh.	500/1500
1	25	Reliance	400/1600

Plus 327 smaller units 1 HP to 20 HP

CONSTANT SPEED—230 VOLT

HP OR KW	MAKE	SPEED
400 HP	Elec. Dyn.	1500
300 KW	G. E. (170 V)	1200
300 HP	Cr. Wh.	1200
250 KW	Al. Ch.	720
150 KW	West.	720
125 HP	Star	1200
100 HP	G. E.	900
75 HP	G. E.	1200
75 KW	G. E. 325 V	1200
50 HP	West.	1200
50 HP	Burke	1800

675 smaller units 1 HP to 40 HP also 115 V & 550 V, DC.

We stock 110V. & 600V. Motors.

SQUIRREL CAGE AND SLIP RING—25 CYCLE

Quan.	HP	Speed	Make
1	650	365 rpm	S.R.
1	350	750	S.C.
1	300	750	S.C.
1	300	375	S.R.
4	200	500	S.R.
1	200	750	S.R.
1	200	750	S.C.
1	200	500	S.C.
1	200	1500	S.C.

Plus 872 smaller units 1 HP to 150 HP

COMPRESSORS

1—3000 CFM	Ingersoll—Steam
1—3000 CFM	Sullivan
1—1350 CFM	Ingersoll
2— 850 CFM	Ingersoll
2— 400 CFM	Chicago
2— 196 CFM	Ingersoll

We stock new units 6 CFM to 290 CFM

Note: We Stock 6000 New Motors, Controls, Frequency Changers

SEND US YOUR INQUIRIES!

ELECTRIC EQUIPMENT COMPANY

PHONE LD65

New and Rebuilt — ROCHESTER, N. Y. — 1 H. P. to 2500 H. P.

MOTORS — MG SETS — TRANSFORMERS — CONTROLS — COMPRESSORS

MOTORS • GENERATORS • TRANSFORMERS

200 KW M.G. SET

200 KW Westinghouse NEMA Frame Generator 250 V. DC 1200 RPM direct Connected to

300 HP. Westinghouse Synchronous Motor 3/60 220/440 Volts 1200 RPM.

AC & DC Panels—Like new. Ship now.

1—400 KW Westinghouse 500 V. DC 750 RPM 800 Amps. Motor—580 HP. Synchronous 3 Ph. 25 cycle 440 V. 750 RPM.

ANODIZING M.G. SET

33 KW Gen. Elect. Type BR. Form C 60 V. DC. Direct connected to 50 HP. 3/60/440/1800 Gen. Elect. Motor.

600 HP GEAR REDUCER

1—600 HP Farrel-Birmingham Herringbone Gear Unit. Type SL Size 30/16 Speed 730 RPM to 115 RPM.

400 HP. GEAR REDUCER

1—400 HP Nuttall (Westinghouse) Type LMR-25 Single Helical Heavy Duty Reducer—6-1 Ratio at 900 RPM with High Speed Shaft Extension for Brake.

400 HP. SYNCH. MOTOR

1—400 HP Westinghouse Synchronous Motor. 3/60/2300/900 RPM. Unity P.F. with direct connected exciter — Late Type.

MOTORS

60-50-25 Cycle in Stock—All Sizes

Slip Ring—Squirrel Cage—Synchronous
All types of Control Equipment.

ALL ITEMS IN STOCK FOR IMMEDIATE SHIPMENT

NIAGARA TRANSFORMERS

1 Phase — 60 Cycle — New

Stock Shipment on sizes listed. Short delivery on sizes up to 5000 KVA—1 or 3 phase, in voltage ratings to 69 KV. Standard taps. Built to A.I.E.E. —N.E.M.A.—A.S.A. Standards.

LISTING OF TRANSFORMERS

Quantity	KVA	Primary	Secondary
3	15	7200/12470Y	240/480
6	25	2400/4160Y	240/480
3	25	7200/12470Y	240/480
3	37½	2400/4160Y	240/480
3	167	2400/4160Y	240/480
3	167	2400/4160Y	120/240

350 KW GENERATORS

2—350 KW General Electric Generators Type MPC, 250 Volt DC, 720 RPM Single Bearing Machines.

REBUILT TRANSFORMERS

3—100 KVA G.E. 1 ph., 60 cy., 2400/4160 pri., 120/240 sec.

3—1667 KVA Wagner 1 ph., 25 cy., 23,000 pri., 575 sec.

ERIE ELECTRIC CO., INC. 124 CHURCH ST. BUFFALO, N. Y. CL. 4758

FOR SALE NEW MERCURY ARC RECTIFIER

Never operated in service: U. S. Gov't, installed but never operated except for Test when sold. Can be operated when inspected. Built by Westinghouse. Rating 500 continuous, 625 2 hrs.

A Complete Westinghouse Unit With All Accessories: Ignitron Tubes, Transformers, Switchgears in cubicles. Drawings, Complete Data furnished on request.

CHARLES WEAVER, *Owner*
4145 PENOBSCOT BUILDING, DETROIT 26, MICHIGAN
Telephone: Woodward 1-1340-1

MOTOR GENERATOR SETS

FOUR (4)—75 KW, Century, DC Generators, 250/125 volts (3 wire), 1200 rpm, coupled to; Century squirrel cage, 3 phase, 60 cycle, 220 or 440 volt motors.

These are 4 bearing units, ball bearing, drip-proof construction, with DC panels.

EMPIRE ELECTRIC COMPANY, Inc.
87 Jay Street, Brooklyn, N. Y.
MAIN 4-5900

Most all units still on foundation. Many may be seen operating

DIESEL UNITS
240/440. 2300 Volts

1000 KVA Elliott-De LaVergne
500 KVA Fairbanks Morse
300 KVA Fairbanks Morse
250 KVA GE-Buckeye
219 KVA (2) Wghse.-Buckeye
200 KVA Fairbanks Morse
187 KVA GE-Buckeye
169 KVA GE-Worthington
160 KVA Wghse.-Buda (Gasoline)
75 KVA (2) General Motors
225 HP Buckeye (belted)

TURBO GENERATOR UNITS
Condensing—Bleeders

3750 KVA Wghse. 3/60/600 V. (Bleeder)
2500 KVA GE 3/60/600 V. Cond.
1825 KVA Wghse. 3/60/2300 V. (Bleeder)
1250 KVA Wghse. 3/60/2300/4150 V. (450#)
1250 KVA GE 3/60/480/240/600 V. (Bleeder)
937 KVA GE 3/60/600 V. Cond.
625 KVA GE 3/60/2300 V. (Bleeder)
625 KVA Wghse. 3/60/600 V. Cond.
375 KVA Wghse. 3/60/240/480 V. Cond.

TURBO GENERATOR UNITS
non-condensing

625 KVA GE 3/60/2300/600 V.
375 KVA (2) Al. Chal. 3/60/240/480 V.
250 KVA GE 3/60/2300/600 V.
125 KVA GE 3/60/240/480 V.
62 KVA GE-DeLaval 240/480 V.

STEAM ENGINE SETS, A.C.
480/240 volts

625 KVA GE-28x32 Chase 4 V.
450 KVA GE-Ames Unif. (Cond.)
450 KVA GE-23x28 Chase 4 V.
312 KVA GE-22x24 Ames Unif.
312 KVA GE-20x24 Chase 4 V.
312 KVA (2) CW-23x24 Skinner Unif.
219 KVA GE-18x20 Ames Unif.
187 KVA Wghse.-Ames Unif. (Vertical)
62 KVA GE-13x14 Ames Unif.

BOILERS

1382 HP Lasker 180# (1941)
600 HP B&W 160# (1933)
500 HP Cleaver Brooks 150# (New)
220 HP (2) Vogt 3 Dr. Low Hd. 160#

TRANSFORMERS

500 KVA (3) Pittsburg 6600/550 V.
400 KVA (3) Wghse. 2300-230/460 V.
333 KVA (3) Wghse. 2300-230/460 V.
250 KVA (3) Wghse. 11430/6600-575 V.
200 KVA (2) Wghse. 2300/460 V.

COMPRESSORS—PUMPS—MOTOR GENERATOR SETS

Above listed units are only a few of our "SPECIALS". Advise your plant requirements.

POWER PLANT EQUIPMENT CO., INC. 39 Cortlandt St. New York, N. Y.

220/440 Volt, 60 cycle SQUIRREL CAGE open, 3 Phase

GUARANTEED REBUILT

QN.	HP	MAKE	TYPE	BEARING	SPEED
1	200	G.E.	IK	S.B.	900
1	200	G.E.	IK	S.B.	720
1	150	G.E.	IK	S.B.	900
1	150	G.E.	IK	S.B.	720
1	150	G.E.	IK	S.B.	1800
2	125	Kiliq		B.B.*	1800
1	100	West.	MS	S.B.	1200
1	100	West.	CS	S.B.	720
2	100	G.E.	IK	S.B.	720
1	100	G.E.	KT-347	S.B.	1200
2	100	G.E.	IK	S.B.	900
1	100	G.E.	IK	S.B.	1800†
3	100	G.E.	IK	S.B.	1800
1	100	West.	CS-504	S.B.	1800
1	75	G.E.	IK	S.B.	600
2	75	G.E.	IK	S.B.	720
2	75	West.	CS-752C	S.B.	900
1	75	G.E.	K-505	S.B.	1200
1	75	G.E.	IK	S.B.	900†
2	75	G.E.	IK	S.B.	900
4	75	West.	CS	S.B.	1200
4	75	G.E.	IK	S.B.	1200
2	75	F.M.	QS-445	B.B.	1800

QN.	HP	MAKE	TYPE	BEARING	SPEED
2	75	G.E.	IK	S.B.	1800
1	60	G.E.	KT-346	S.B.	900
1	60	G.E.	IK	S.B.	1200
1	60	F.M.	QS-444	B.B.	1800
1	60	G.E.	KT-333	S.B.	1800
4	60	G.E.	IK	S.B.	1800
1	50	G.E.	IK	S.B.	600
3	50	West.	CS	S.B.	900
1	50	G.E.	KT-342	S.B.	900
1	50	G.E.	KT-342	S.B.	900†
2	50	West.	CS-443	S.B.	1200
1	50	G.E.	KT-327	S.B.	1800
2	50	G.E.	IK	S.B.	1800†
3	50	G.E.	IK	S.B.	1800
1	40	G.E.	KT-342	S.B.	720
1	40	F.M.	BH12D	S.B.	900
1	40	G.E.	KT-338	S.B.	900
1	40	West.	CS	S.B.	1200
2	40	G.E.	IK	S.B.	1800†
2	40	G.E.	IK	S.B.	1800
1	35	G.E.	IK	S.B.	720
1	35	Triumph	B12	S.B.	960
3	30	G.E.	KT-312	S.B.	1800

QN.	HP	MAKE	TYPE	BEARING	SPEED
3	30	G.E.	IK	S.B.	1800
5	30	West.	K-385	S.B.*	3600
1	25	G.E.	IK	S.B.	720
1	25	F.M.	B12P	B.B.	720
1	25	Century	SC-30	S.B.	1200
1	25	F.M.	BH12A	S.B.	1200
1	25	Ideal	A 18	S.B.	1200
1	25	West.	CS-471	S.B.	1800
1	20	F.M.	KBV	B.B.	1200
1	20	G.E.	KT-322	S.B.	1200
1	20	G.E.	KT-312	S.B.	1200
1	20	G.E.	K-384	B.B.	1800
1	20	West.	CS-384	S.B.	1800
2	20	G.E.	K-328	B.B.	3600
4	20	Line-Weld	Frame 320	B.B.	3600
2	15	West.	CS	S.B.	720
1	15	Wagner	15 T	S.B.	1200
1	15	Ideal	A	S.B.	1200
1	15	G.E.	KT-502	S.B.	1200
1	15	G.E.	KT-752	S.B.	1800
1	10	G.E.	IK	S.B.	1200
1	10	G.E.	KT-752	S.B.	1200

* Splash proof † 2200 volt

SLIP RING MOTORS

We offer from stock the following 220/440 volt, 60 cycle, 3 phase, GUARANTEED REBUILT equipment, unless otherwise noted.

QUAN.	H.P.	MAKE	TYPE	SPEED	DESCRIPTION
1	15	G.E.	MT 512	900	S.B.
1	80	G.E.	MT 332	900	
1	30	Al. Ch.	ANY	900	
2	40	Al. Ch.	ARY 444	1800	splash proof, S.B.
1	40	G.E.	MT 336	900	S.B.
1	50	G.E.	I-M	900	S.B.
2	60	G.E.	MT 558	900	
1	60	G.E.	MT 346	900	
1	60	G.E.	I-M	900	
1	60	West.	CW 505	1200	
1	75	G.E.	I-M	720	
1	100	G.E.	I-M	720	
1	100	G.E.	I-M	900	
1	125	G.E.	I-M	720	
1	150	G.E.	I-M	900	
1	150	G.E.	I-M	1800	2300 volt
1	200	G.E.	I-M	900	

TOTALLY ENCLOSED MOTORS

FAN COOLED, BALL BEARING, 220/440 volt, 60 cycle, 3 phase, GUARANTEED REBUILT, unless otherwise noted.

QUAN.	H.P.	MAKE	TYPE	SPEED	DESCRIPTION
1	7½	G.E.	KF 284	1800	
1	7½	Reliance	AA 324	1200	XP, NEW
3	10	L.A.	JS 326	1200	
1	15	West.	CB 328	1800	XP, NEW
1	25	L.A.	JS 384	1800	
1	40	G.E.	K 486	1800	XP, NEW
1	50	Master	FB 484	3600	XP, NEW
1	50	Al. Ch.	ARZZ 444	1800	NEW
1	75	G.E.	K 506	1200	

POWER EQUIPMENT COMPANY

8 CAIRN STREET — P. O. BOX 534 — ROCHESTER 2, N. Y.

Telephone: Genesee 5629

MOTOR GENERATOR SETS

125 K.W. 230 Volt D.C. Burke 440 Volt 3 phase 60 cycle 900 RPM Synchronous Motor.

100 K.W. 250 Volt D.C. Gen. Elec. 3 brg. 440 Volt 3 phase 60 cycle 900 RPM. Synchronous Motor.

50 K.W. 250 Volt D.C. Westing. 4 brg. 220/440 Volt 3 phase 60 cycle 120 RPM motor.

20 K.W. 125 volt D.C. Allis Chalmers 3 brg. 440 volt 3 phase 60 cycle 1800 RPM motor.

D. C. GENERATORS

100 K.W. 230 volts 1200 RPM Westinghouse SK

75 K.W. 250 volts 600 RPM Westinghouse SK

MOTOR REPAIR & MFG. CO.

1557 Hamilton Ave., Cleveland, Ohio

BOILERS

10 to 1000 H. P.

NEW-USED RECONDITIONED

Steam, Gas and Electric Power Equipment

J. PARKER THOMPSON CO., INC.

507 FIFTH AVE., NEW YORK CITY

MURRAY HILL 7-6547-8-9

TRANSFORMERS—60 CYCLE

SINGLE PHASE

4—	3333 KVA., Westgh.	132,000—7620/13200Y
3—	100 KVA., G.E.	44,000—2300
3—	300 KVA., G.E.	33,000—2300/4000Y
6—	200 KVA., G.E.	33,000—2300/6900
1—	25 KVA., Westgh.	33,000—2300
3—	250 KVA., Westgh.	22,000—2300/4000Y
3—	750 KVA., Westgh.	13,200—440
3—	100 KVA., Moloney	13,200—240/480
3—	75 KVA., G.E.	13,200—240/480
4—	75 KVA., G.E.	13,200—440
3—	37½ KVA., G.E.	13,800—230/115
3—	25 KVA., G.E.	13,800—230/460
3—	150 KVA., Moloney	7620/13200Y—120/240
3—	75 KVA., Moloney	7620/13200Y—120/240
2—	75 KVA., G.E.	4160/7200Y —120/240
6—	500 KVA., Westgh.	2400/4160 —120/240
2—	30 KVA., G.E.	2200 —100/122

THREE PHASE

1—	7000 KVA., Allis Chal.	6900—2400
1—	2000 KVA., G.E.	69,300—13800/23900Y
1—	7500 KVA., G.E.	33,000—13800
1—	1050 KVA., G.E.	6600/11400Y—445 (Rotary transformer)
2—	1500 KVA., Allis Chal.	2460/2220—480/240
1—	250 KVA., G.E.	2300/4000Y—575
1—	200 KVA., G.E.	575—230

UNIT SUB-STATION

1—Unit Sub-station 500 KVA., General Electric, Type MI 6. Out-door Load Centre Unit Substation complete. Transformer 4160 Volts Delta-120/208Y secy.

GROUND FAULT NEUTRALIZER

1—Ground Fault Neutralizer Type J, Form C., 60 Cy., for 34,500 volt system 40/10 continuous rating. With by-pass equipment including steel structure, and remote operating panel.

TURBO GENERATING UNIT

1—100 K.W., G.E. Non-condensing, 3600 RPM. #27, 160, 3 ph., 60 cy., 600 volts. (Can be reconnected 480 volts full capacity. Can be reconnect to 240 volts at rating 100 KVA.) Dir. Ctd. exciter.

60 CYCLE MOTORS

1—250 H.P., G.E., slip ring, 3 ph., 60 cy., 2400 volt, 1800 RPM. two bearing self contained, with shaft for coupling.

2—50 H.P., G.E., slip ring, Type MT 356, 3 ph., 60 cy., 440 volt, 600 RPM.

MOTOR GENERATOR SET, 125 VOLTS

1—20 K.W., Westgh., 125 volt, 160 Ampere, 1130 RPM., with 30 H.P. 3 ph., 60 cy., 2200 volt induction motor with starting compensator.

ARCHER & BALDWIN, INC.

75 West St., New York 6, N. Y. Tel: BO. 9-9275-9276

MOTORS — M. G. SETS — TRANSFORMERS

SQUIRREL CAGE MOTORS
3-Ph., 60-Cy.

Qu.	HP	Make	Type	Volts	RPM
1	400	G.E.	IK	2300	514
1	400	G.E.	KT-412	2300	450
1	300	Al. Ch.	AR	440	1760
1	250	Whse.	CS	2300	1160
1	200	Al. Ch.	AR	220/440	580
2	125	Al. Ch.	AR	2200	1750
1	125	Whse.	CS-761	440	1750
1	125	G.E.	KT-508	2300	875
2	125	C.W.	1206Q	440	430
3	100	Whse.	CS-663	440	1750
1	100	Al. Ch.	AR-226	2200	1160
5	100	F.M.	HS-201C	440	880
1	100	Al. Ch.	AR	550	690
1	100	F.M.	H-241B	440	450
1	100	Whse.	CS-938	2200	514
1	100	Al. Ch.	AR	440	495

SLIP RING MOTORS—CONSTANT DUTY—3-Ph., 60-Cy.

Qu.	HP	Make	Type	Volts	RPM
1	3000	G.E.	MT	2200	356
1**	1200	Cr. Wh.		2200	237
2**	1000	Al. Ch.	ANY	2200	235
2	500	G.E.	1-16-M	2300	450
1***	400	G.E.	MT-574	550	585
1**	400	G.E.	I-M	2300	500
1**	400	Al. Ch.	ANY	2200	595
2	400	G.E.	MT-412	2200	440
1	300	G.E.	1-E15-M	2300	1200
1	300	Al. Ch.	ARY	2200	595
1	250	Al. Ch.	ARY	440	440
1	250	Whse.	CW-1106	2200	580
1	250	Whse.	C.W.	550	514
1	250	G.E.	MT-414	2200	300
1	200	G.E.	IM	2200	600
1	150	G.E.	I-813 M	2200	1750
1***	125	Whse.	C.W.-870	2300	900
1	100	F.M.	420-C	440	900

—Mill type pedestal bearing. *—3-bearing.

SYNCHRONOUS MOTORS
3-Ph., 60-Cy.

Qu.	HP	Make	P.F.	Volts	RPM
1	4000	Whse	.8	5000	600
1	3500	Whse	1.	4800/2400	720
1	1500	Whse	.8	2300	720
1	700	G.E.	.8	2300	720
1	450	G.E.	.8	440	360
1	400	Whse	.8	440	600
1	298	Al. Ch.	1.	2200	900
2	250	Al. Ch.	.9	2200	514
1	200	Whse	.8	440	360
1	150	G.E.	1.	2200	900
1	150	G.E.	.8	550	450
1	150	G.E.	.8	2200	600
2	125	El.Mch.	1.	4800/2400	900
1	125	G.E.	.8	2200	900
3	100	Whse	.8	440	1800
1	100	Whse	1.	2200	1200
1	100	Ideal	.8	440	900
2	100	G.E.	.8	440	600

With the above we can supply manual, semi-magnetic or full magnetic, reduced or full voltage control.

TRANSFORMERS—(OIL COOLED)

Qu.	K.V.A.	Make	Type	Phase	Voltage
2	4500	G.E.	HT	3	27000/13500/2300
3	4000	G.E.	H	3	22900/2300/4000Y
1	3750	Whse	S	3	67000/14400/2400
5	500	G.E.	HT	3	14400/13200/480
3	500	G.E.	H	1	13200/11880/220/440
30	100	G.E.	HT	1	14400/12870/240/480
3	100	Whse	AUTO	1	2400/4160Y/1385/2400Y
3	100	Whse	SS	1	12075/10955/230/460

MOTOR GENERATOR SETS

Qu.	KW	Make	R.P.M.	Volts DC	Volts AC
1	2400 (3U)	Al. Ch.	720	525	4800/2400
1	2000	Whse	600	600	2300
2	1500	Whse	514	250	4600/2300
1	1500 (3U)	Al. Ch.	720	525	4800/2400
2	1000	G.E.	514	575	4000/2300
1	750	Whse	900	600	2300
1	700 (3U)	G.E.	720	250	2300
1	600	G.E.	720	300	2300
1	500	Al. Ch.	720	525	2300
1	500	C.W.	720	250	2300/440
1	500 (3U)	Whse	1200	130/240	4000/2300
1	200	Whse	900	250	2300
1	200	Ridgeway	900	275	2200
1	155	G.E.	720	250	2300/440
1	150	Al. Ch.	1200	250	2300/440
1	100	Ridgeway	1200	275	4000/2300
1	85	C.W.	1200	250	2300/440
1	75	Whse	900	75	2300
1	75	Al. Ch.	900	250	2300
1	75	Star	1200	230	440/220
2	25	Whse	1200	125/240	440/220

3U—3 unit set.

ROTARY CONVERTERS

2925/2565 K.W. 225/285-V D.C., G.E., 8000 A.D., 450-R.P.M., with booster.

2750—K.V.A. Transformers, 6900-V, 3-PH., 60 CY., complete control & C.D. distribution cubicles. Will Rewind Transformer to Suit Your Current.

DIRECT CURRENT MOTORS

Qu.	HP	Make	Type	RPM
1***	2000	Whse	Encl (Rev)	600
1***	2400	Whse	Encl (Rev)	600
1***	1600	Whse	Encl (Rev)	600
6***	1500	Whse	Encl (Rev)	600
4***	1200	Whse	Encl (Rev)	600
2***	1250	Whse	Mill (Rev)	300/600
4***	800	Whse	Encl (Rev)	600
1	350	G.E.	CD 189	1150
1	325	Whse	QM	450/900
1	300/250	El. Dy.	#22	400/1200
1	200	Whse.	Mill (Rev)	300/1200
1	180	G.E.	MPC	400
1	150	Al. Ch.	Mill (Rev)	400/1200
2*	150	Cr. Wh.	S3H	890
1***	125	Whse	SIC-190	600
1	100/125	Rel	1995 F	300/1200
2	100	Rel	1050 T	400/1200
1	90/100	G.E.	MPL	625/1125
1*	50/75	Rel	1995 F	300/1200
1*	50/75	Whse	SK 151 L	400/1200
1	50	Whse	SK	300/1200
1	40	Al. Ch.	E 127	850/1750
1	35	G.E.	CD 125	400/1200
1	35	G.E.	CD 147	300/1200
2	35	G.E.	RF 14	500/1500
1	35	Rel	T	250/1000
1	22½	Whse	SK 150	400/1200
2	25	G.E.	CD 123	400/1200

Above are all 230 V DC except where marked ***.
***—Pedestal Bearing 525/600 V DC Mill design Rev.—(designed for mill reversing service) *—T.E.F.C.

T. B. MAC CABE COMPANY

4314 CLARISSA STREET — Phone DAvenport 4-8300 — PHILADELPHIA 40, PENNA.

TANKS

40 STEEL STORAGE TANKS
IMMEDIATE DELIVERY:
CAPACITY: 6500 gals.
CONDITION: Excellent.
SIZE: 76" ID x 27'10" overall.
Write, wire or phone for specifications and print.

BOILER

IMMEDIATE DELIVERY:
Walsh-Weidner Boiler, including Foster super-heater.

6206 Sq. Ft., 60,000# steam per hour at 450 psi, ASME code stamped. Oil or gas fired.

Write us for our complete list of New & Rebuilt Explosion-Proof & TEFC MOTORS which we have for immediate delivery.

Heat and Power Co., Inc.

70 PINE STREET — DIGBY 8-0373 — NEW YORK 5, N. Y.

JOHN H. BENSON — ROY L. WILIMZIG

PUMPS!!

2—20"x16" Economy AA511, 12000 GPM, 75' Hd. 1200 RPM; 300 HP Motor and starters; NEW 1948.
2—Ditto, except 40' Hd. and 900 RPM.
2—10"x8" Morris No. 6S Slurry Pumps, 900 GPM, 100' HD, 875 RPM, 60 HP, with or without motors.
1—Northern Hydraulic 3000 PSI, 99 GPM, Size 5820, 580 RPM, NEW SURPLUS.
1—4" GOULDS 500 GPM, 1320' Hd. 3500 RPM, Fig. 3360, 250 HP.

1000 OTHER PUMPS IN STOCK! PHONE, WRITE OR WIRE!

C & S MACHINERY CO.

1708 N. 8th St.
St. Louis 6, Mo.
GA-4290

TRANSFORMERS

FOR SALE

2— 150 KVA. 60 CY. 1 PH. 2400-240/480 SCOTT TAPS.
6— 100 KVA. 60 CY. 1 PH. 2400-240/120.
6 75 KVA. 60 CY. 1 PH. 2400-240/120.
9— 50 KVA. 60 CY. 1 PH. 2400-240/120.
7—37½ KVA. 60 CY. 1 PH. 2400-240/120.
8— 15 KVA. 60 CY. 1 PH. 2400-480/240.

ALSO ALL TYPES OF AIR COOLED AND PHASE CHANGERS.

ATLANTIC TRANSFORMER CO.

5143 N. 2nd St. — Philadelphia 20, Pa.

BOILERS

10 to 5000 H.P.
Diesel, Steam Turbine, Engine

GENERATORS

Heavy Power Equipment
Industrial — Chemical Process Equipment
UNUSED — RECONDITIONED

DEAN G. STRICKLER & ASSOCIATES
1346 Connecticut Avenue, N.W.
Washington 6, D. C. • DuPont 3386

Our 30th Year

HEMPHILL EQUIPMENT PROVES ITS VALUE

Member of The National Industrial Service Association, Inc.

TRANSFORMERS—60 Cycle

Qu.	KVA	MAKE	TYPE	Ph.	VOLTAGES
1	1000	GE	Pyranol	3	4150 x 2400
1	1000	GE	Auto	3/2	4150 x 2406
1	1000	GE	Auto	3	3810Y-2300Y
1	500	Kuhl.	OISC	1	4600 x 2300V
3	400	GE	H	1	6900 x 2250V
1	300	Pitts.	ODSC	1	7800 x 440V
3	250	Maloney		1	13,800 pri., 220/440 sec.
1	200	Whse.	Auto	3/2	4150 x 2300
1	200	Pitts.	OISC	1	4000 x 110/220
1	200	GE	Auto	3/2	4150 x 2400
1	150	GE	KS	1	2300 x 230
1	100	Pitts.		1	2750 x 110/220
3	100	Wagner	RCKV	1	240 x 120/120
2	100	Whse.	SK	1	4400 x 220/440 Taps
2	100	Newark	Dry	3/2	440 x 220

MOTOR GENERATOR SETS
3 Phase, 60 Cycle

Qu.	KW	MAKE	SPEED	DC	AC
2	1500	GE	600	275	4000 Syn.
1	1000	GE	514	600	4000 Syn.
1	1000	GE	514	600	2300/4150 Syn.
1	300	GE	1200	250	2300 Syn.
1	150	GE	1200	125/250	2300 Syn.
1	150	Whse.	600	125	4150 Syn.
1	125	CW	1200	125	2300 SC
1	100	CW	1200	125	220/440 SC
1	100	El.Mach.	1200	125	4150 Syn.
2	75	GE	1200	250	220/440
2	75	GE	1200	125	220/440 SC
6	75	GE	1200	60	220/440 SC
1	50	Ridgeway	1200	550	220/440 SC
1	50	Whse.	900	250	220/440 SC
2	40	El.Mach.	1750	125	440 SC

SLIP RING

1	2500	GE	MT	6600	257
1	300	Whse.	CW	440	600
1	250	Whse	CW	440	600
1	200	Whse.	CW	440	600
1	100	GE	IM	440	400
1	75	GE	MT	220	1200 Vert
1	75	GE	MT	440	900
1	60	GE	MT	220	1750
1	60	GE	MT	440	900
1	50	GE	MT	220	1720
1	50	GE	MT	220	1200
1	50	Whse.	CW	220	900
1	50	GE	MT	220	1700
1	50	GE	MT	220	600
1	40	GE	MT	220	1200
1	40	GE	MT	2200	1200

J. L. HEMPHILL & CO.

This Seal is *Your Guarantee*

1604 53rd STREET, NORTH BERGEN, N. J.
PHONE NEW YORK — LONGACRE 5-3227
PHONE NEW JERSEY — UNION 3-2600

COMPRESSORS VACUUM PUMPS

BUY SAFE — BUY AMERICAN
Since 1902
ALL MAKES — ONE QUALITY
— SALE OR RENT —
STATIONARY — PORTABLE

SPECIAL
868 CFM—125 LBS.
17/10x12 CHICAGO PNEUMATIC
O-CB
Inspect Our Plant

American Air Compressor Corp.
Dell Ave. & 47 St., N. Bergen, N. J.

COMPLETE DIESEL PLANT

3—700 HP Winton 8 cyl. 4 cycle, 360 RPM diesels. 500 KW Elec. Mchy. 3/60/2300 alternators. Switchboards and complete plant auxiliaries. For sale in whole or part. Condition excellent.

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Quality **SINCE 1906** Wente Motors

WIDE SELECTION UNUSUAL VALUES

THEIR ELECTRICAL CONSTRUCTION HAS BEEN REBUILT... BY EXPERTS

SQUIRREL CAGE
3 ph.—60 cy.—220 or 440 V.
(Other voltage as noted)

Qu.	HP	Make	Type	Speed
1	50	G.E.	I (2200 V.)	900
2	50	Al. Ch.		900
1	60	G.E.	KT Vert.	1800
4	60	G.E.	KT (2200 V.)	1200
4	60	G.E.	KT547Y (2200 V.) SP	1200
1	60	West.	CS (TEFCBB)	1200
1	75	West.	CS (TEFCBB)	1200
1	60	West.	CS Gearhead	332
1	100	G.E.	KT (2200 V.)	900
4	100	G.E.	K (TEFCBB)	1200
1	110	G.E.	KTP	1200
1	125	G.E.	FT	3600
3	125	Al. Wh.	AR (BB)	450
2	150	Al. Ch.		1750
1	250	G.E.	KF (Vert.)	3600

SLIP RING—SYNCHRONOUS
3 ph.—60 cy.—220 or 440 V.
(Other voltage as noted)

1	50	Ideal	AV	600
1	50	G.E.	I	700
1	60	Ideal	AVX	1200
1	70	KW G.E.	TS (.7PF)	1200
1	75	West.	CW	400
1	75	G.E.	I	520
1	75	Fr.Morse	BV (2200 V.)	1800
4	100	G.E.	I-16 (2200 V.)	450
1	100	KW G.E.	ATB (8PF)	900
4	100	G.E.	MT566Y(2200V.)8F	450
1	100	G.E.	MT556	900
1	125	Fr.Morse	T (2400 V.) (PF1.0)	900
1	150	West.	CW	450
1	300	West.	CW (3 Bear.)	600
1	625	Kva E.M.	(.8 PF)	900

D.C.—230 VOLT
(Other voltage as noted)

1	50	West.	SK	850
2	50	Reliance	T	3700
1	50	West.	SK (115 V.)	500
1	60	West.	SK (115 V.)	500/1500
1	75	Diehl	K11	700
2	75/100	Reliance	T1650	800/900
2	75	West.	SK, frame 183	850
1	100	West.	SK, frame 184	1200
1	100	Cr. Wh.	CM	600
1	130	Cr. Wh.	CMC (550 V.)	1200
1	150	West.	SK	400/1200
1	150	West.	SK	850
1	200	Cr. Wh.	CMC	450
2	200	Reliance	T2550	800/900
2	200	G.E.	TLC-74	1350/4000
1	250	West.	SK	1050

M-G SETS

1— 45 KW West. 60 V DC—440 V AC 1200 RPM
4— 60 KW G.E. 60 V DC—440 V AC 1200 RPM
2— 75 KW El. Prod. 220 V DC—440 V AC 1200
1—100 KW West. 250 V DC — 440 V AC 1200
1—100 KW West. 250 V DC — 440 V AC 900
1—100 KW Reliance 250 V DC — 220 V AC 1200
1—100 KW Ridge 275 V DC — 440 V AC 1200
1—150 KW G.E. 275 V DC — 440 V AC 900

ALSO—4000 motors other than listed from 1 HP to 300 HP.

Wente *The Wente Electric Co.,*
Hamilton 203 NO. FOURTH ST. Phone 4-8128 *Ohio*

SLIP RING MOTORS 3-Ph., 60 Cy.

HP	Volts	Make	Speed
500	2300	G.E.	450
450	440/220	Whse.	514
400	2300	G.E.	1200
350	2300/440	G.E.	450
300	440	Whse.	2600
250	440/220	Whse.	600
250	2200/550	G.E.	450
250	550/440	G.E.	1200
200	440	G.E.	450
200	440	G.E.	450
188	4000/2300	G.E.	1800
150	440/220	Whse.	600
150	440/220	Whse. (2)	1800
145	4000/2300	G.E.	1800
125	550/440	G.E.	1200
100	440/220	G.E.	600
100 (2)	440/220	Whse.	900

SYNCHRONOUS MOTORS 3-Ph., 60 Cy.

HP	Volts	Make	Type	RPM
400	440/220	G.E.	ATI	600
300	2200/400	G.E.	Ts	720
300	440/220	G.E.	ATI	600
250	440/220	Whse.	HR	277
250	440/220	G.E.	ATI	600
250	4000/2300	El. Mchy.	Syn.	600
240	2300/440	G.E.	ATI	720
200	440/220	G.E.	Ts	720
200	4150/2300	Whse.	G	1800
120	440/220	G.E.	ATI	900
110	440/220	G.E.	Ts	257
100	440/220	Whse.	G	1800
75	2200/440	Whse.	GE	600

PLATING UNIT

1—5,000 amp., 4/6 volt (or 2,500 amps., 8/12 volts) A.P. Munning, double commutator, dir. conn. to 50 hp. G.E. sq. cage motor.

CIRCUIT BREAKERS

2—2000 amp., GG E, 3 pole, 600 v., air
2—1600 amp., ITE, 3 pole, 600 v., air
2—1200 ampere, Whse., 3 pole, 600 v., air
1—400 amp., 37000 V., G.E., Type FHKO-236 outdoor type, high interrupting capacity.

SQUIRREL CAGE MOTORS

HP	Volts	Make	Type	Speed
650	440	G.E.	FT	3600
500	2200/4000	Elliot	SC	1800
350	2200	G.E.	KT	1200
300	2200	G.E.	FT	3600
250	440	G.E.	IK	720
200	440	G.E.	IK	514
200	440/220	Whse.	CS	1200
200	440/220	G.E.	KT	1800
200	2200/440	G.E.	KF	720
200	2200/550	Cr. Wh.	SC	900
200	2200/440	G.E.	KT	1200
200	440/220	G.E.	IK	450
150	440/220	Whse.	CS	900
150	440/220	G.E.	IK	450
150	2200/550	Whse.	CS	900
150	440/220	G.E.	KT	720
150	440/220	Howell	B. Brg.	1800
150 vert.	440/220	G.E.	KTP	1200
150	440/220	G.E.	IK	514
150	2200/440	G.E.	KT	600
100	2200/440	G.E.	K	1200
75 (5)	550	G.E.	KF	1800

A. C. GENERATORS

1—520 kva, 600 rpm, 2300/440/220 V., G.E.
1—250 kva, 720 rpm, 2300/440 v., G.E.
1—225 kva, 600 rpm, 220/440 v., G.E.
1—225 kva, 720 rpm, 2300/440 v., G.E.
1—150 kva, 900 rpm, 480/240 v., G.E.
3— 75 kva, 1800 rpm, 480/240 v., Whse.

D. C. MOTORS

HP	Volts	Make	Type	Speed
350	230 (2)	G.E.	CD	1150
250	230 (2 new)	Cr. Wh.	CMC	1800
150	230 (3)	Whse.	SK	850
150	230	Cr. Wh.	TEFC	900
100	230	Cr. Wh.	CMC	625
100	230	G.E.	CD	1750
75	230	G.E.	CD	1150
75	230	Whse.	SK	850

MOTOR GENERATOR SETS

1—300 kw, 1200 rpm, 250 V., Whse., conn. to 350 hp, 1200 rpm, 2300 v. sq. cage
1—165 kw, 1200 rpm, 240 v., G.E., conn. to 250 hp, 1200 rpm, 440/220 v., squirrel cage
1—100 kw, 250 v., Hertner, 1200 rpm, connected to 150 hp, 220/440 v., synchronous
1—75/90 kw, 250 V., 1200 rpm, G.E. conn. to 135 hp, 440/220 V., sq. cage
1—75 kw, 125 v., 1200 rpm, G.E. conn. to 120 hp, 2200/440 v., syn. motor.
1—50 kw, 250/125 V., 1200 rpm, 3-wire, G.E., conn. to 75 hp, 440/220 V., sq. cage

TRANSFORMERS 60 Cy.

3—333 kva, G.E., 13,200—2300 V.
3—333 kva, Whse., 2400—480/240 V., Dry
3—250 kva, G.E., 6900/12,800—230/460 V.
3—250 kva, Whse., 11,000/22,000—2300 V.
3—250 kva, Whse., 2300—208 V.
3—200 kva, Whse., 13,200—2300 V. (Inertown)
6—150 kva, Al. Chal. 2400—240/120 v.
1—150 kva, Whse, 8K, 13200-125/215 v., 3 ph.
3—100 kva, Whse., 4600/2300—230/115 V.
6—100 kva, G.E., 4600/2300-230/115 v., NEW
3—100 kva, G.E., 440-115/230 v., dry, 1 ph, new
2—75 kva, G.E., 480—240/120 v., Pyranol
3—50 kva, G.E., 480—240/120 V., Pyranol

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458 SEVENTH ST. HOBOKEN, N. J.

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SPECIAL OFFERINGS

TURBO-GENERATORS

2—4000 KW, 4160 V, 60# NEW
2—4000 KW, 2300 V., 150# Cond.
1—3500 KW, 2300 V., 150# Cond.
1—3500 KW, 4000 V., 150# Cond.
1—3000 KW, 4000 V., 150# Cond.
1—2500 KW, 480 V., 150# Cond.
1—2500 KW, 550 V., 250# Cond.
1—2000 KW, 550 V., 175# Cond.
1—1500 KW, 2360 V., 200# Cond.
2—1250 KW, 2300 V., 225# Cond.
1—1000 KW, 2300 V., 250# Cond.
1—1000 KW, 4150 V., 280# N.C.
3—1000 KW, 480 V., 180# Cond.
1—1000 KW, 480 V., 150# Cond.
1— 750 KW, 550 V., 170# Extr.
1— 750 KW, 2300 V., 175# Extr.
1— 500 KW, 2300 V., 170# Extr.
1— 500 KW, 2300 V., 150# Cond.
1— 300 KW, 2300 V., 200# N.C.
1— 150 KW, 2400 V., 150# N.C.

ENGINE GENERATORS

1—600 KW, 2300 V., Unit.
1—500 KW, 230 V., D.C., Unit.
3—375 KVA, 550 V., Unit.
1—312 KVA, 440 V., Unit.

REFRIGERATION UNITS

3—300 ton motor or turbine driven

BOILERS

2—50,000#, 300#
1—30,000#, 425#
1—35,000#, 150#
2— 500 HP, 200#
3— 500 HP, 400#
1— 438 HP, 200#
2— 400 HP, 150#
4— 150 HP, 150# Se. Mr.

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4—600 HP B & W Sectional header 250#—superheat, ASME Code.

1—140,000# New Steam Generator 600#, also Super
2—70,000# 500 psi
2—30,000# B&W 450# superheat, air heater
1—1250 B&W Sectional header 200#—super
2—600 HP Stirling 200#
2—516 HP & 2—315 Heines 165#
2—400 HP B&W Steel Sectional Header Boilers
Also smaller Boilers & Fire Tube Boilers

TURBO UNITS

2—10,000 KW Turbo-Generator—Cond.
1— 7,500 KW Turbo-Generator—Cond. 600#
1— 5,000 KVA Turbo-Generator 450# with condens.
2— 5,000 KW Turbo-Generator—Cond.
2— 3,000 KW Turbo-Gen. and Cond., one aut. extrac.
2— 2,500 KW Turbo-Generators and Condensers
3— 2,000 KW Turbos & Condenser
2— 1,500 KW Turbos & Condenser
2— 1,250 KW Turbos & Condenser
2— 1,000 KW, also 750 & 500 KW Units, Condens.
Non-Cond.:—300—500—750—1000—1500—2000

Frequency Changers—Motor-Generators & Diesel-Generators

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G.E. 3 phase, 60 cy., 2300 V.

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STerling 3-6515

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General Motors, Mod. 8-268-A-450 H.P. Diesel Engines direct connected to following:
(1) Generator—312 KVA—80% P.F.—3 ph.—60 cy. 240/480 volt.
(2) Generator—300 KW—230 volt D. C.

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2—General Electric, Type B.T.A., frame 552, 75/18.5 HP, adjustable speed, 1070/267 RPM, 3 phase, 60 cycle, 208 volt, semi-enclosed, externally ventilated motors, in excellent condition.

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1—4 Ply Leather Belt 28" x 74'. Practically new.

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33000/240-480 Volt 60 Cycle with Taps—600,000 Series

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FOR SALE

1—300 KW, 220 DC Eliott Turbine Generator—A-1 Condition.

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PARTIAL LISTINGS OF EQUIPMENT AVAILABLE FOR YOU

MOTOR GENERATOR SETS
3 Ph. 60 cycle

KW	DC Output	AC Input	Speed	Make
1800	250	2300/4000	600	G.E.
800(3U)	400/600	2300	1200	Whse.
400	250	220/440	1200	G.E.-W
300	250	440	1200	Whse
300	250	2200	1200	A-C
300	250	440	900	G.E.
200	250	440	1200	G.E.
100	250	4300	1200	Whse.
75	125	440	1200	G.E.
50	250	220	1200	A-C-W
50	125	440	1800	C-W
32	125	440	1800	G.E.
25	230	220	1200	Rel.-G.E.
22	125	220	900	A-C
20	125	220	900	G E.-A-C
12½	250	220	1800	Whse
10	250	220	1800	Whse.
7½	250	220/440	1800	Whse.
7½	125	220/440	1200	Whse.
5	230	440	1200	Whse.
1	115	220/440	1800	G.E.

ROTARY CONVERTERS

KW	DC Volts	AC Volts	RPM	Make
1700	250	*	514	G.E.
1100	250	*	720	G.E.
300	600	33000	1200	Whse
150	250	*	1200	Whse.

*Will wind for any voltage

SYNCHRONOUS MOTORS
3 Phase, 60 Cycles

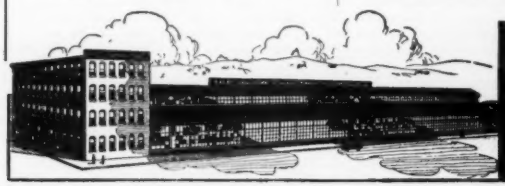
HP	RPM	Volts	Mfr.
3000	720	4800	Whse.
500	514	440	G.E.
435	720	2300	G.E.
430*	750	2300	Whse.
320	900	2300	G.E.
300	1800	2300/4160	G.E.
250**	225	2200	G.E.
225	900	4160	G.E.
220	600	2300	G.E.
220	277	2300	Whse.
200**	150	220	G.E.
175**	225	220	G.E.
160	600	440	G.E.
160	164	440	G.E.
150	1800	2200	G.E.
150	1200	220	Whse.
150	900	440	Star
150	720	440	Whse.
150*	300	220	Chandeyson
120**	225	220	E-M
115	164	220	G.E.
115	164	220	G.E.
100	1800	2200	Whse.
100	1200	220	Whse.
95	1200	220	Burke
75	1200	220/440	Delco
75	900	2300	G.E
60**	360	2200	G.E.
60	300	220	E-M
50	1200	220/440	Delco
50	900	220/440	Whse.
50	720	440	G.E.

*25 cycles.
**Rotor and stator only, engine type.

SLIP RING MOTORS
3 Phase, 60 Cycles

HP	RPM	Volts	Mfr.
500	900	440	G.E.
500*	900	2200/4160	G.E.
450*	900	2200/4160	G.E
375	1800	2300	A-C
350	514	220/440	G.E.
300	1200	440	Whse
300	720	2200	A-C
300	600	440	G.E.
250	600	440	A-C
250	300	2200	A-C
235	1800	220	G.E.
200	1800	440	A-C
200	440	440	A-C
150	1800	440	G.E.
150	900	2300	A-C
150	720	440	G.E.
150	600	440	A-C
100	1200	440	Whse.
100	720	440	A-C
100	400	440	G.E.
75	720	440	A-C
75	600	440	A-C
60	1800	220/440	A-C
60	900	440	A-C
50	1200	220	F-M
50	900	440	Whse.
50	720	440	A-C
45	1200	440	Whse.
40	1800	220/440	Whse.
40	900	220	A-C
40	720	2200	A-C
40	600	220	G.E.

*New.



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1—Driven by 40 H.P. 1170 R.P.M. 3/60/220/440 Volts—Type K—Frame 445 General Electric motor.

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2—240 HP 14x17 Modernized Diesel Engines, needle Bearing, open head, direct connected to 3/60/480V. F & M Alternators.
1—31 KVA Fairbanks-Morse Diesel Electric Light Plant.
3—Complete Switchboards; Woodward Governors; Complete Starting Equip; Maxim Silencers; Complete Cooling System; Crane Oil Purifiers; And other auxiliary equipment.

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10—250 HP Westighouse—Type CS—S. S. Bearing—Frame 875-S —1800 RPM—3—60—2300 Volts.

10—200 HP Wagner—Type RP—S. Bearing—Frame 26V—1800 RPM—3—60—440 Volts.

4—150 HP General Electric—Type K—TEFCBB—Frame 6335—720 RPM—3—60—550 Volts.

2—100 HP Allis-Chalmers—Type ARW—Skirted Frame—S. Bearing—1800 RPM—3—60—2300/4150 Volts.

10—75 HP Wagner—Type CPI—TEFCBB—Frame 504—1800 RPM —3—60—220/440 Volts.

10—60 HP Wagner—Type CPI—TEFCBB—Frame 445—1800 RPM —3—60—220/440 Volts.

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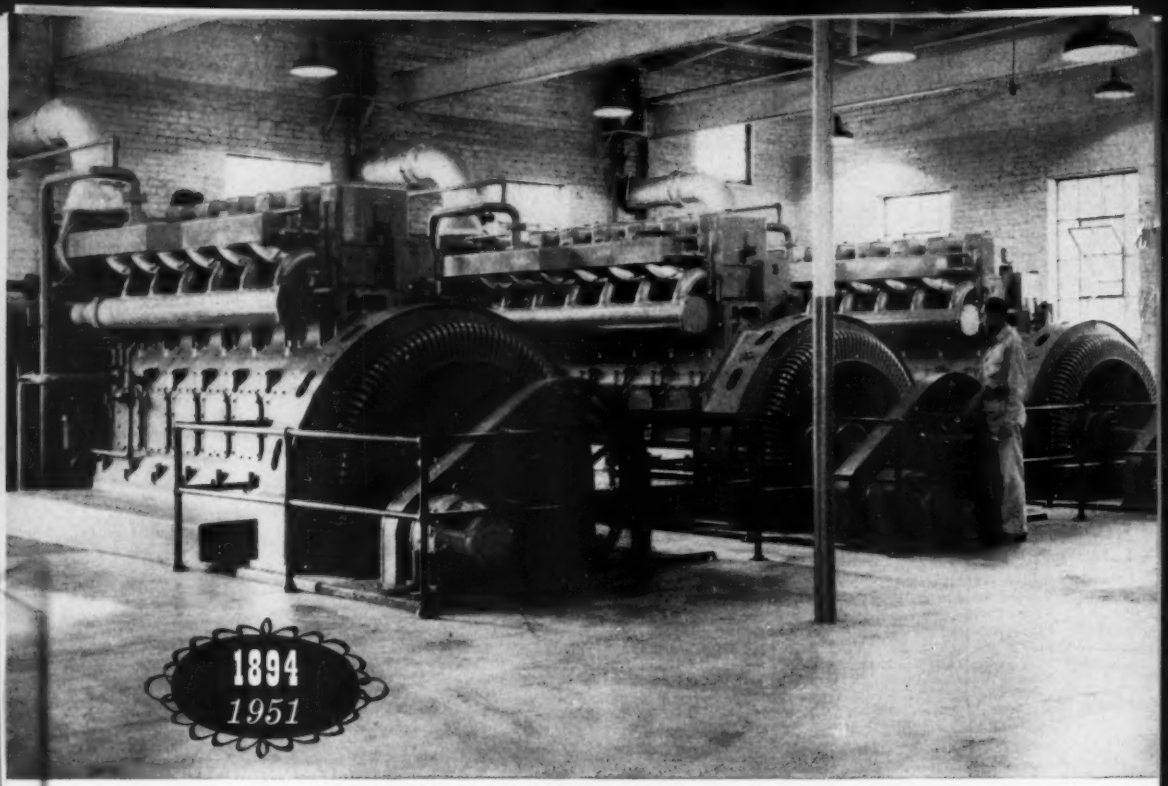

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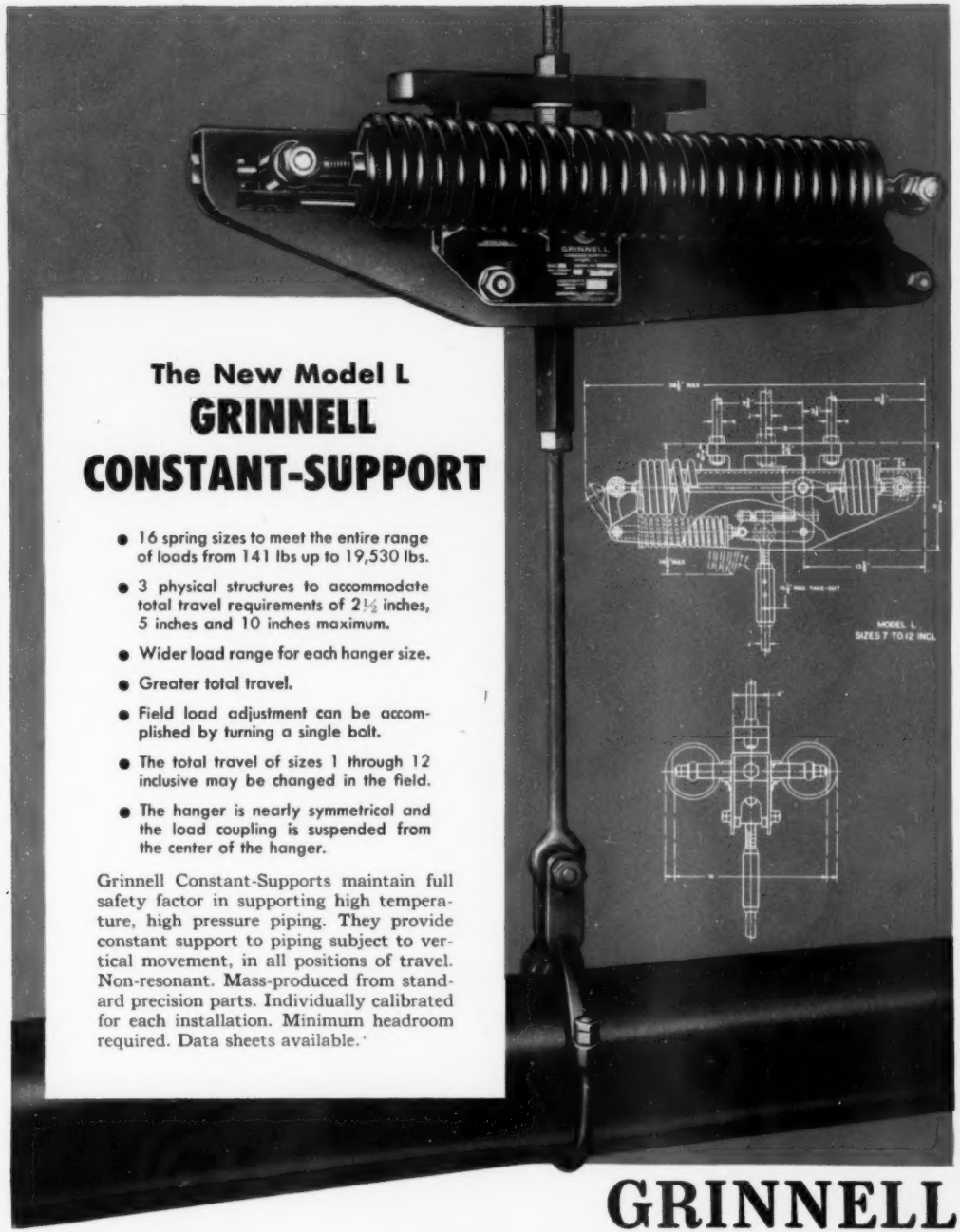

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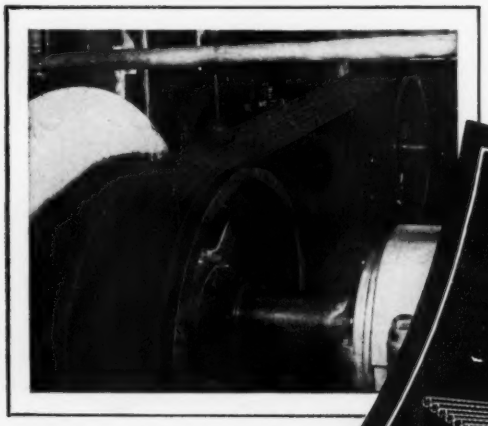

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